JOURNAL

OF THE

FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA,

FOR THE

PROMOTION OF THE MECHANIC ARTS.

VOL. LIII.] APRIL, 1867. [No. 4.

EDITORIAL.

PNEUMATIC DESPATCH.

THE great length and crowded state of chief thoroughfares in many of our principal cities through which great quantities of merchandise in small packages as well as mail matter, are daily transported, is drawing public notice in no small degree to the plan which is now, and for some years has been, in successful operation between the terminus of the North-western Railway and one of the District Post Offices in London.

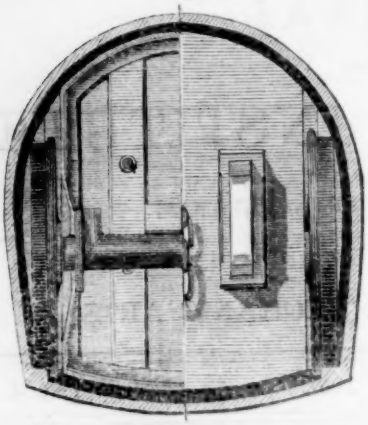
Under these circumstances, we think it desirable to give a detailed account of the above apparatus and its operation, the material for which is derived from an editorial article in the *Practical Mechanics' Journal* for June, 1863.

The general principle of the Pneumatic Despatch may be briefly explained as follows:

A small cast iron tunnel or tube, arched above, but nearly flat below, about two feet nine inches high, and having nearly the same width at its broadest part, provided with a pair of rails, runs from one station to the other. On these rails run four-wheeled wagons, of which Fig. 1 shows an end view and half cross-section. The general

outline of the wagon conforms, as the drawing shows, to the section of the tunnel, but there is an absolute clearance all around, *of more than an inch.*

Fig. 1.



The tubes composing the tunnel are cast in ordinary lengths, and are put together with leaded joints, like the ordinary water or gas mains. They are laid with gradients, varying from 1 in 100 to 1 in 80, and with three curves, two of one hundred and ten feet radius and one of forty feet. This last curve is very short, but works well, and proves the admirable flexibility of the system.

The apparatus for giving motion to these carriages, is situated entirely at one end of the line, namely, at the Euston Station, and may well be considered, on account of its novelty, efficiency and singular operation, as the most remarkable feature of the whole apparatus.

Fig. 2.

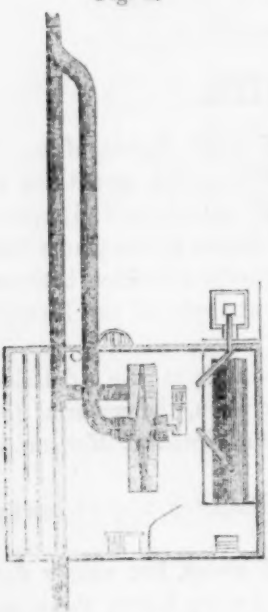


Fig. 2 shows in ground plan the position of this motor in its relation to the boiler, engine and tunnel, and Fig. 3 shows on larger scale, a vertical section of this apparatus, which is known as the Pneumatic Ejector.

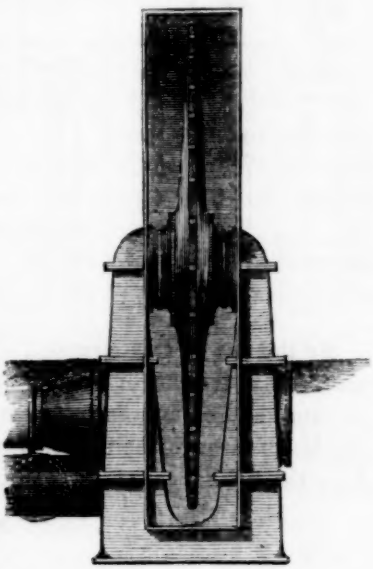
This consists of a hollow circular disc of sheet iron, shown edgewise in the middle of Fig. 3, supported on a short horizontal axis, to which a small high-pressure engine is directly geared. This disc is inclosed in a rectangular, round-topped casing or box, of boiler-plate, twenty-two and a half feet wide by four feet thick. Connected with its lower portion at one side, is a large tube or continuation of the tunnel, while another similar tube, leaving the tunnel at a point more distant from its terminus, (see Fig. 2,) forms a connection

with the interior of the hollow disc, by means of the air-trunk, which is seen in Fig. 3, to surround the lower half of the rectangular casing.

This air-trunk may, however, by appropriate valves, be shut off from the tunnel and opened to the outer air, as also may the rectangular casing mentioned before.

The action of this instrument in a general way, may be easily described. The hollow disc being rotated by the engine, draws in air at its centre from the air-trunk, and expels it into the rectangular case. If the former is connected with the tunnel, and the latter with the outer air, a partial vacuum is produced, and cars are sucked through from the further station. But when the casing is connected with the tunnel, and the air-trunk with the atmosphere, air is forced into the tube, and drives a carriage from the nearer to the further station.

Fig. 3.



Thus much for the general statement; but it will be observed that the form of this pneumatic ejector, or blower, is unusual, and may well demand closer study.

The hollow disc already mentioned, is about twenty-one feet in diameter, formed of two thin sheets of iron, which are but two inches apart at the outer edge, but separating as they approach the axis, so as to form such surfaces of revolution as would be generated by curves, which are nearly hyperbolas, having a common asymtote at the axis, and terminating at the periphery, in tangents, almost parallel to each other and to the plane of revolution.

These discs are stiffened and connected by radial ribs, and the shaft is fixed in them by rib-feathers. Circular mouths at the centre of the discs, correspond to similar mouths terminating the air-trunks, with which they make tight joint by means of ordinary cup-leathers.

The property of the curve which determines the shape of the disc, is, that a circumferential section at every distance from the axis, shall

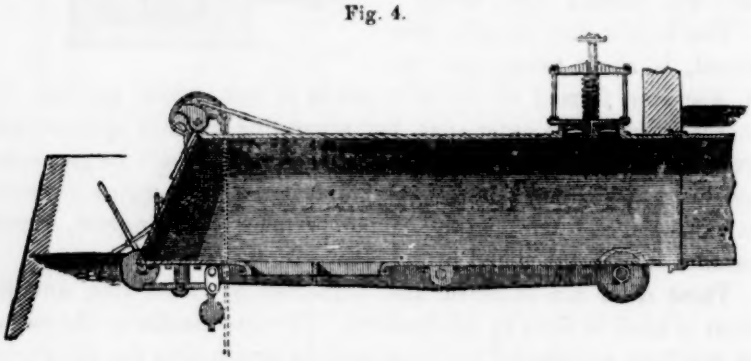
have the same area, which also equals that of the indraught openings just described.

This remarkable "ejector" appears capable of giving a higher duty than any fan previously used, and the actual pressures obtained, as will be seen from the following table, are strictly proportionate to the square roots of the velocities:

Diameter of Ejector in feet.	Number of revolutions per minute, and pressure in inches of water.							
	50	60	70	80	90	100	110	120
20 feet.	0·65	0·94	1·27	1·66	2·11	2·63	3·15	3·74
21 "	0·73	1·04	1·42	1·85	2·35	2·90	3·51	4·18
22 "	0·83	1·19	1·62	2·11	2·67	3·29	4·00	4·75
23 "	0·87	1·26	1·71	2·24	2·83	3·48	4·33	5·04
24 "	0·95	1·36	1·86	2·43	3·07	3·73	4·59	5·49
25 "	1·02	1·47	2·00	2·62	3·32	4·11	4·96	5·90
26 "	1·12	1·62	2·20	2·88	3·64	4·45	5·44	6·48
27 "	1·20	1·72	2·35	3·07	3·88	4·79	5·80	6·91
28 "	1·30	1·87	2·56	3·32	4·21	5·15	6·29	7·48
29 "	1·37	1·98	2·68	3·52	4·45	5·53	6·65	7·92
30 "	1·47	2·12	2·89	3·77	4·77	5·92	7·13	8·49

By the use of this ejector, (which is, in the case under consideration, run at the rate of one hundred to one hundred and ten turns per minute,) and of appropriate valves in the connecting pipes, the cars are *blown* through the tunnel from the Euston Station, or sucked back from the further terminus. In the first case, the necessary supply of

Fig. 4.



air is obtained from out of doors, by means of passages under the floor, and in the latter the outdraught is discharged by the same means.

The arrangement for allowing the car to come out of the tunnel at either terminus is shown in Fig. 4, which represents the termination of the tube with its various appliances. Above, at the right, is seen a spring-valve, which may be so adjusted that the resistance offered to the escape of air from in front of the car, when near the terminus, may be such as to bring it to rest at a convenient point outside. Vertically under this, is seen a wheel at the end of a long lever, upon which presses the advancing car. This lever thus depressed, sets free at its other end, the detent of the door, which closes the tube or tunnel, and a counterweight then quickly raises this last, a moment before the car reaches it.

The velocity at which the cars or trains are run in this tunnel, is about sixteen and a half miles an hour, the short curves before mentioned necessitating a reduction of speed. This velocity is obtained by the use of a twenty-two foot ejector, making, as we have said, one hundred to one hundred and ten turns per minute, which develops a pressure of three to four inches on a water-gauge.

Motion is given to the ejector by means of a small steam-engine of fifteen inches diameter and sixteen-inch stroke, set upon an inclined framing, and having its crank keyed directly to the shaft of the ejector. The steam is used at a pressure of forty pounds.

About fifteen trains, each way, are now the daily work done by this apparatus, which is clearly but a small per centage of its capacity; and to effect this, steam must be kept up all day, by which great loss of duty occurs; yet the whole consumption is but twenty-one bushels of coal per diem, at a cost of 6*s*., or about 5*d*. per double journey.

The general arrangement of parts and ground plan of the Euston terminus, is shown in Fig. 2, where we see at the right the boiler next to it, the engine attached directly to the ejector, from which two tubes lead to the tunnel, a long one for suction, and a short, direct passage, for blowing. Opposite to the end of the tunnel, on the further side of the room, is a short closed passage, which acts as an air buffer to the cars, should the valve arrangement before described fail to bring them to rest at the desired point, namely, on the track between these two.

From the foregoing statement, it will be seen that the Pneumatic Despatch, as devised and arranged by Mr. Rammel, and as practically operated in London, possesses many marked features by which it is distinguished from all the pneumatic railways and the like, which have been before employed.

The loose fitting of the car in the tube, the low-pressure and large quantity of air employed to drive the trains, as well as the peculiar form of the ejector, are all novelties of great importance to the success of the scheme. It will also be noticed that the speed is not high, and it should be remembered in the discussion of similar plans, that to employ a high speed for long distances, would demand an accuracy and permanency in the tunnel or tube hardly to be reached under the existing conditions of the problem, in an engineering point of view.

Engineering Items.

An immense reservoir.—M. Morin presents, in the name of M. Graeff, Chief Engineer of the Bridges and Embankments in the Department of the Loire, an account of the reservoir of Furens, near St. Etienne, in these words:

Since the presentation which was made by M. Graeff on the 23d of April, 1866, which was an account of the theory of the motion of water in reservoirs, which served for irrigation, one of the reservoirs in which this theory has achieved entire success, has been erected at Furens.

The city of Saint Etienne, in which formerly a subterranean basin was used, to hold, at the source of the Furens, all the necessary water, has contributed a sum of at least one million, for the construction of this reservoir by state engineers. By this work, the city secures the right of using this reservoir for storing the superabundant water of the Furens during the spring and autumn, and in fact to use it for municipal purposes, and for regulating the supplies during the droughts of summer and winter, to the manufactories, of which there are sixty-eight on the stream.

The old bed of the Furens, in the part where it forms a vast basin, has been shut off down the river by a bar fifty metres, or one hundred and sixty feet, high, of which the profile was adjusted according to the type of equal resistance. This bar is made entirely of ordinary masonry, and only the cap is composed of regular blocks, which are of cut stone; the bar is founded on a rock which encases its base and sides.

It was commenced in 1862 and finished in 1866, and was officially inaugurated on the 28th of October, though it was filled in the spring, and furnished, during the summer, the city and manufactories of the valley.

At its greatest rise, the Furens did not give out more than 15 cubic metres in a second, from observations made during ten years by M. Graeff, but on the 10th of July, 1849, a water-spout occurred in the valley, which was at least 6175 acres in extent, and there resulted from it an inundation of the city of Saint Etienne. This immense overflow reached the great volume of 4624 cubic feet in a second, and subsequent observation showed that the invasion of the city by water, did not occur until the out-flow of the Furens attained 3284 cubic feet a second, which was very unusual.

The observations made of the quantity of water given out in this condition, led to the conclusion that the reservoir, to which these extraordinary rises furnished 3284 cubic feet in a second, should be capable of receiving 7,063,000 cubic feet. It was constructed large enough to accommodate 14,126,000 cubic feet, or twice the amount which was produced by the water-spout of 1849.

According to arrangements made in this immense reservoir which has just been erected, it becomes easy to hold in reserve twice a year, spring and autumn, 84,750,000 cubic feet, which can gradually be dispensed to the city and manufactories. The first cannot possibly use more than 21,189,000 cubic feet, and there then remains 6,357,000 cubic feet to divide between sixty-eight manufactories.

These details suffice to show the importance of similar works, for changing courses of torrents, which so often cause devastation and disaster, into reservoirs which are necessary to the health of cities as well as to arts and manufactures.

The whole cost of the reservoir was about $800,000, and the revenue received pays fully five per cent. on this, without counting the increased value of the manufactories supplied from this source.

The Paris belt railway was opened on the 25th of February; it is 22 miles in length, including the branch to Mt. Parnasse, and is entirely within the city walls, crossing the Seine at two points, about seven miles apart, by bridges, one of which at the Point de Jour, is very remarkable for the beauty and ingenuity of its structure.

A railway and road-bridge over the Po, at Mezzana Corti, has just been finished. Its length is 3310 feet, made up of ten spans of 196 feet, with the piers and abutments. The superstructure con-

sists of two lattice girders 24 feet 6 inches deep, placed 27 feet 3 inches apart, and connected below and above by plate iron cross-girders. The cross-girders below, are connected by short plate-girders under the timbers on which the rails are placed. The lower system of cross-girders carries a double line of rails, and the upper a roadway. The upper cross-girders have an arched form on their upper surface, and are connected by longitudinal timbers on which the planking for the roadway is laid. The most remarkable feature of this bridge is, however, the substructure and the method of its formation. Iron caisons 49·2 feet by 19·2 feet, and 8·8 feet deep, closed at top but entered by four tubes each four feet in diameter, provided with skips and equilibrium chambers, were sunk upon the site of the piers. Compressed air was used to remove and exclude the water, and workmen and materials were introduced by means of the tubes, &c. The whole interior was finally filled in with concrete.

The Hoosac Tunnel is again let to contract. When finished, its extent will be 4½ miles, of which as yet only 4600 feet are finished. The central shaft is to be elliptical in section, 27 by 15 feet, and will have a depth of 1030 feet; only 400 feet have as yet been sunk.

The London and North-western Railway, as we learn from our excellent cotemporary *Engineering*, has a capital of $350,000,000 and forty miles of double track laid with steel rail.

Steel-faced armor-plates capable of resisting chilled shot, which have been found to penetrate the ordinary armor, have been manufactured by Messrs. Cammel & Co., of Sheffield, in slabs having a surface of 48 square feet, and a thickness of 6 and 7 inches. Each plate weighs about 6 tons. The weld is said to be readily effected in the rolling, and to be very good.

Railway across the English channel.—The President of the London Society of Engineers, in his inaugural address for this year, alludes to the project above-named, in the following manner, as we learn from the *Mechanics' Magazine:*

"At the present moment it is proposed to bring together nations between which there is a sea of twenty miles, and there would appear to be no substantial reason to consider this task impossible either by the construction of a multiple span bridge or a subway across." Which shows us that this stupendous enterprise is contemplated in a serious and even practical light by others than its proposers.

The English iron trade.—From the same authority, the address

of Wm. H. Le Feuvre, Esq., we quote the following remarkable statement, which must interest our readers, since the facts related cannot fail to have a world-wide influence upon one of the most important industries.

"I would desire to call your attention also to a circumstance which has lately begun to assume a serious importance to us as engineers, and which promises to endanger one of the most extensive of our manufactures, that is, the production and manufacture of iron. This has been carried on to such an extent now in Belgium, that, after an interval of a very few years, the run of competition is altogether on the side of Belgium manufacture. They successfully compete with the most extensive of our iron works in England. As examples, I would mention, that during the progress of the Exhibition lately erected in Amsterdam, it was found that while the earlier portions were being constructed, it was cheaper to import the iron-work from England; but before the work was completed a considerable quantity of iron-work was supplied from Belgium and Holland, as it could be obtained at a lower price, and from that period to the present, the competition has run hard between those countries and our own. In the new Pimlico Wheel Works, in London, which, as may be known, perhaps, to most of you, was constructed by our firm, we had also to give way to the importation of iron-work from Belgium, and it is the case also with regard to some works we are now carrying out in India, where the iron-work is actually shipped from Belgium to London and reshipped to Bombay, at a less cost than it could be purchased from English manufacturers. I cannot but view these circumstances with regret and apprehension, and I hope that before such a state of things is permitted to become more serious, some co-operation may be induced amongst our leading manufacturers, so that this branch of our industry may be not altogether wrested from us. I mention these instances as facts which have come under my personal observation and experience. We find one of our leading railway companies (the Great Eastern Railway) being provided with locomotives from France, which resulted after a competitive tender, to which our leading firms were invited. The inroads of foreign competition have at length reached to such an extent that one of our leading railway companies invited a French firm to compete with our manufacturers for the supply and erection of the iron-work of their terminal station in London. I cannot, therefore, but repeat that there are good grounds for the fears entertained with respect to this branch of our industry, and trust that

these remarks may lead to some practical suggestions being made during the present session, with the view of ameliorating the present condition of our iron manufacturers."

In reference to the above statement, we should mention that the editor of *Engineering* explains this effect as resulting only from that revolution in iron manufactures which the general introduction of the Bessemer process has inaugurated, and which has rendered the great coal regions no longer the best location for iron-making, but rather the localities where the best iron is found. The reason of this is, that while formerly an inferior ore could (by great expense of coal in refining) be converted into a first rate iron, we now can at once (provided we start with a good ore) obtain a superior iron or steel with a very small outlay of coal. The old refined iron thus finds itself unable to compete with the new steel. As England takes the lead in both of these branches, however, the new as well as the old, nothing is to be feared in the future from the development and change above noted.

Boiler explosions and their prevention.—Since we last alluded to this subject in our previous issue, the account of two boiler explosions, which might have been prevented by a thorough system of inspection, and which resulted in the loss of fifteen lives, has reached us in the Reports of the Manchester Association, published in the *Mechanics' Magazine*.

The first of these, was the explosion of a small portable boiler on a sailing vessel, where it was used to drive a windlass engine for hoisting cargo. A precisely similar boiler, from the same manufacturers, exploded a few months before, with like disastrous effects. This boiler was a very small one, 5 feet high 2·5 feet in diameter, with internal conical fire-box and two horizontal water tubes; working pressure, 100 lbs. The cause of explosion was very evident, the man-hole, 13 by 10 inches, was not strengthened by any mouth-piece, or ring, but had only an ordinary internal cover, supported by one or two bolts suspended from arched bridges. The shell was ripped in every direction, radially from this hole. By the explosion of this small boiler, five men were laid dead upon the deck, two were blown overboard, and one fatally injured, while the vessel itself, with bulwarks splintered in every direction, and deck drenched with blood and strewn with dead bodies and fragments of iron, presented a spectacle horrible beyond description.

The safety-valve with which this boiler was provided, proved also to be of a most improper and *unsafe* construction, being so arranged that

its adjustment (with a spring, a set screw) was a mere matter of guess-work, so that it was at any time a matter of doubt whether it was arranged to lift at 50, 100 or 200 lbs. pressure.

The second explosion which occurred, was in a dye-works, and resulted in the loss of seven lives and the demolition of the whole building. It was the result of using bad iron in a cylindrical flue boiler, internally fired, carrying 100 lbs. pressure, and quite new. The owners of this one had bargained for a boiler to be of the best material and abundantly strong, and had paid an unusually large price to the builders, on their assurance that such was the character of the article supplied. On the inquest, however, the foreman of the manufacturers stated that some of the iron used in the boiler in question, was of very poor quality, and therefore totally unfit for the use to which it was put. It thus appears that a good system of official inspection, would have prevented the use of either of these boilers, and therefore, as a consequence, their disastrous effects.

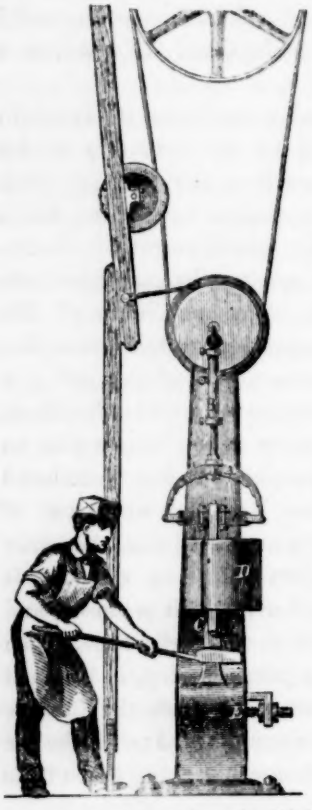
Hoists for iron furnaces.—At the last meeting of the Franklin Institute, attention having been directed by the Secretary in his report, to the hydraulic hoists lately erected at the Rosedale Iron Words, Mr. Coleman Sellers described a similar instrument, which had been for many years in use at the establishment of Messrs. Whitney & Sons, where it was used for moving the car-wheels into and out of the annealing ovens or pits. The peculiarity of this machine is that a system of pulleys are separated by the action of a hydraulic ram, thus securing, by an inverse action of the pulley, a rapid motion in the hoist from a slow one in the ram. The President, Mr. J. V. Merrick, then stated that in many of our iron works, an air-hoist was used with good results. This plan was first introduced by Mr. John Fritz, at the Bethlehem Iron Works, at which two of these machines were now in use, one with a single column, the other with two. The arrangement is as follows: A long cylinder is provided, having the same height as the hoist. This is closed, and has a stuffing-box at the top, through which passes a wire rope, which is attached to a piston within, and passing over a pulley, is fastened at its other end to the platform of the hoist. Air from the furnace blast is supplied to the cylinder at about five pounds, and raises the car with its load, the weight of the piston counterbalancing that of the platform.

Similar hoists to the above are used at the Lehigh Crane Iron Words, Catasauqua, and at the Thomas Iron Works, Hokendoqua,

Pennsylvania. The President further described the plan now largely used in pavement hoists, or those employed to raise goods from stories below the ground to the level of the pavement. In this case the platform was simply supported on the head of a ram, which was raised by the hydrostatic pressure due to the head of water obtained from the mains or from an elevated cistern. Prof. R. E. Rogers also stated that he had inspected a hoist of this description in the Charing Cross Hotel, London, with a lift of 50 feet.

We hear that one of these hydraulic hoists is to be erected in this city, with a lift of 80 feet.

The dead stroke power hammer.—At the last meeting of the Franklin Institute, there was exhibited a model of this improved instrument, in its most efficient form. This apparatus, invented by Mr. Thomas Shaw, and first put in operation by Mr. Philip S. Justice, may be described as follows:



It consists of a ram, which is suspended by means of a flexible connection, such as a leather belt or combination of leather belts, from a cast-steel spring, through which a reciprocating motion is communicated to it, from a crank. The line of motion of the ram or hammer is determined by guides.

It follows, from this form of construction, that the hammer or ram acquires a velocity, not only such as is due to the descending motion of the crank, but also to the accumulated motion or force of the upward stroke, which is absorbed and stored in the spring, and which this spring, from its bow-like shape and action, is enabled to communicate to the ram, in the most efficient manner, that is to say, in such a way as to develop the highest possible velocity.

This velocity, at the moment of striking, will be far beyond that of any other portion of the machine. The effect of a blow increases,

as is known, with the square of its velocity, and we can therefore understand, that even a light hammer, striking the work with the immense speed obtained as above, will produce effects of a character enormously greater than we would expect, when considering only its weight and the motion of the machine generally. Thus, a 25-lb. hammer will forge down 2½-inch bars, with great rapidity; a 100-lb. hammer will forge down bars of 4½ inches; a 1000-lb. hammer will forge blooms of 9 inches; while the little 15-lb. hammer, intended for light work, will readily work bars of 1¼ inches.

Another advantage obtained by this high velocity and light weight, is, that the blow is so sudden that there is no time to communicate the force to the anvil, but the work of compression in the body treated, absorbs a large part of the shock. With a hammer of greater weight and slower motion, this advantage would be sacrificed proportionally, more of the force of the blow would be transferred to the anvil, and less work would be effected in the intermediate piece under treatment. This circumstance secures to the instrument two important features, durability and economy of maintenance. We thus find that one of these hammers, run for a year on very severe work, required *no repair*, while a trip hammer used under identical conditions, averaged $3 a day, the year through, for repairs.

Improvements in oil presses, by John Shinn, were described at the last meeting of the Institute. These consist in the introduction of corrugated surfaces, covered in turn by sheets of iron gauze, between the bags in which the stearine and oil are separated by the action of pressure. By this means the drainage is not restricted to the edges of the bags, but is distributed over the entire surface, by which the process is rendered very rapid and complete.

Novelties in Chemistry and Physics.

Preparation of Oxygen.—Winkler states that bisulphate of soda may be substituted for sulphuric acid in obtaining oxygen from the black oxide of manganese, with the advantage that it forms a fusible mass not so likely to cause breakage of the retort, as the hard cake of sulphate of manganese otherwise produced.

A new chemical toy.—Take a sheet of thick white bibulous paper, without size, such as is used for printed books. Soak it first in

a strong solution of bichromate of ammonia, and when dry, treat it likewise with an alcoholic solution of gum benzoin. Such a sheet, so folded that it will stand on one edge, if lit at its upper edge, so that it burns without flame, is converted as it burns, into a system of green serrated leaves, much resembling those of the fern. It meanwhile emits a pleasant odor.

Experiments illustrating the vibrations of strings.—In the proceedings of the Royal Institution, which we have just received, we find an interesting account of some experiments in the above subject, exhibited by Professor Tyndall, at one of the meetings of the learned society named.

Among these, the following attracted our special attention: A rod was firmly fixed in a vice, in such a way that its shadow could be thrown upon a screen, and was then struck sharply at certain points, by which means it was made to divide itself into two or more vibrating segments and half segments, the former showing themselves as shadowy spindles, and the latter as fans upon the screen. The nodes were marked by dark points of stationary shadow.

Again, a fine platinum wire was connected with a tuning-fork, and heated by a galvanic current. The fork being now caused to sound, the wire received a vibration to which it responded, swinging as a whole, by which means its middle portion was cooled through its rapid motion in the air. The wire being then slacked, divides itself into two or more segments, of which the nodes are intensely heated and the ventres cooled, so that the appearance produced is that of many luminous spindles intensely bright at their points, but fading gradually into darkness at their thicker portions. The nodes show excess of brightness over the wire at rest, because the cooling of the other parts allows more of the current to pass.

Test for amount of Carbon in steel.—It is stated that, in conducting the Bessemer process at Manchester, a quick and sufficiently accurate estimate of the amount of carbon present in any sample, may be made by dissolving a given weight in nitric acid, and comparing the color of the solution with that of a known standard. The brown tint increases in intensity with the amount of carbon present.

Proposed improvement in manufacture of steel.—The renowned chemist, Graham, announces, as the result of some experiments lately made, that iron at a low red heat, will take up by an absorptive action—without chemical union—4·15 vols. of carbonic

oxide. To effect, however, a combination of the carbon here present with the iron, requires a much higher temperature, while this higher temperature, on the other hand, is unfavorable to the before-mentioned absorption. He therefore suggests that an alternation of these temperatures might be of advantage in the process of steel-making by cementation.

The crystallization of glycerine on a large scale, was lately effected by the combined action of the cold weather and the jarring of the cars in which the substance was carried. The crystalline mass, when melted, would not again freeze at a temperature of 0° F. while at rest. While melting, it maintained a constant temperature of 45°.

Useful products of the pine tree are now manufactured at Paris, as follows: Vegetable wadding, raw vegetable wool, flannel, pine extract, spirits and soap.

Ice machine, by M. Toselli.—Some years ago this gentleman devised a simple instrument in which ice was made by the solution of equal quantities of carbonate of soda and nitrate of ammonia in water. In this way a pound of ice was made at the cost of twenty-five cents. He now finds that by dissolving the carbonate of soda first, and then adding the other salt, a much more intense cold is obtained; or, by substitution of a cheaper salt, not named, the same effect can be procured at a less cost. Thus, by his present plan, six pounds of ice cost but ten cents.

Vegetable fibre is converted into a substance resembling inulin, as is shown by Wm. Skey in the *Chemical News*, 1867, page 1, by the action of ammonio-nitrate of copper in solution.

Sodium amalgam, when used for the extraction of *silver*, works with remarkable efficiency, as we learn from various statements and letters published in the same journal.

Wild's magneto-electric machine (of which a full description, with plates, was published in this *Journal* for December), according to a statement published by the Abbé Moigno, in *Les Mondes* and the *Chemical News*, heats very much when run continuously.

Fifteen electric lights were employed to illuminate the *Bois de Boulogne* during a skating fête this winter, as we learn from the same authority. The lights, each produced by forty Bunsen cells, were arranged on elevated platforms or towers erected for the purpose, and illuminated the ponds, the approaches and the skaters, in the most beautiful and satisfactory manner.

A work on spectrum analysis as applied to the heavenly bodies,

illustrated with eighteen photographs of the most remarkable spectra, and of apparatus used in their study, has been prepared by Mr. Wm. Huggins, and published by W. Ladd, the well-known maker of philosophical apparatus.

An electric light is used in the shops of the North Spanish Railway.

Spectroscopes.—From a priced catalogue of these instruments, just issued by John Browning, we extract the following points, which will be of interest to some of our readers. The amateur's spectroscope, stated to be a good instrument, is furnished for £2 2*s*. The direct vision spectroscope (in which the dispersion, without deflection of the ray, is obtained by means of four internal reflections and four refractions in two prisms) may be carried like a small spy-glass, in the pocket, and costs £4 4*s*. The student's spectroscope, so arranged that two spectra may be seen at once and compared, fully adapted to all purposes of analysis, costs £5 5*s*. The model spectroscope, from £10 10*s*. to £50. The star spectroscope, from £7 7*s*. to £18 18*s*. Lastly, the micro-spectroscope, fitted for those tests and examinations described by Dr. Sorby in the last volume of the *Chemical News*, costs £5 5*s*.

The Bessemer process.—We have received from Mr. Z. S. Durfee, 418 Walnut Street, a very interesting pamphlet, describing the Bessemer or Pneumatic process of making iron and steel, with details of the machinery used, the peculiarities of the metal produced, the uses to which it has been applied, and a list of all the works in which this process is in operation.

Photo-sculpture.—We learn from the *Philadelphia Photographer* that the process named above, and whose details (as practised in London) were some time since described in this *Journal*, is now carried on by Messrs. Huston & Kurtz, 895 and 897 Broadway, New York. The theory of the operation may be thus briefly described: Twenty-four photographs are made of the subject, from as many directions, and from each photograph is cut out a profile, which being used as a tool or template upon a block of clay in the corresponding position, produces at last a figure having correct profiles in all directions, and therefore needing but a few touches (developing the re-entrant angles) to render it a perfect likeness. In the plan as practised in England, the sitter was placed in the middle of a platform and turned round by twenty-four movements in front of a single camera.

In the present case, however, twenty-four cameras are employed, and as many plates are exposed at once, thus saving much time and avoiding risk of error from changes in position of the sitter.

Civil and Mechanical Engineering.

(Continued from page 161.)

THE NEW YORK "CENTRAL PARK."

By WILLIAM H. GRANT, Superintending Engineer.

CHAPTER II.

1st.—TRIAL-SAMPLES OF ROAD CONSTRUCTED AT THE COMMENCEMENT OF THE PARK, AND REFERENCE TO THE VARIOUS PLANS.

2d.—PRELIMINARY AND FOUNDATION WORK IN GENERAL CONSTRUCTION.

GRAVEL *roads, Telford roads and MacAdam roads. Theory as to road foundations. Relative cost of the samples. A modification of Telford plan. Preference developed, in the use of the roads, for the gravel road. Total lengths of the roads of the Park, and lengths of the different kinds and widths constructed.* GENERAL CONSTRUCTION.—*Surveys and location of roads. Grades and Curves. Preparation of road-bed. Drainage. Road hydrants. Theory of drainage, rainfall, &c. Observations on the drainage of the Park at large. Recapitulation of the drainage works and water pipes of the Park.*

At the commencement of the road-making operations of the Park, in 1858, three different samples of road were made. Suitable ground was selected for the purpose, on the line of an intended road, the width of which was fixed at 45 feet.

The samples were from 350 to 500 feet in length, and were intended to test, as far as practicable, the cost, relative qualities, merits and facilities of construction of *gravel roads, Telford roads* and *MacAdam roads.*

The gravel road was first commenced. The samples were not all entirely completed until the forepart of 1859.

The depth of road material for all the samples was fixed at fifteen inches.

The details of gutters, silt basins, surface and sub-drainage, &c., were matured during the progress of the work.

The only material change that was afterwards made in the plans of the samples was in the reduction of the depth of the road materials.

In the sample of gravel road the stone bottoming was composed of two layers; the first was a layer of stones, from 3 to 5 inches thick,

and 8 to 18 inches long, laid flatwise upon the road-bed, the interstices being filled with stone chips, or spalls. Above this layer was placed the paving, or "Telford" course, composed of stones from 7 to 9 inches in depth, set on edge crosswise of the road, and wedged tightly together, and otherwise treated as will hereafter be described. [See Plate I.]

The object of the double course was, principally, to give the depth of material considered necessary, without the rigidity, and some other inconveniences of construction, caused by using larger and deeper stones in a single course of paving. It was also further considered, that the bottom layer of stones would serve to make a more equable foundation, on soft ground, for the superincumbent materials, and at the same time more effectually prevent the working up of the underlying earth;—as stated at the time in a report made upon the subject, 'The pressure upon any given point, by carriage wheels or horses' feet, will be distributed (by means of the bottom stones) over a larger area, the upper course, wedged and bound together, acting in some measure as an arch, and transmitting and distributing the pressure to the course below. The tendency of the foundation stones to work upward—a matter that has been a good deal discussed by road-makers—is to be remedied by this means, together with sub-drainage and such an entire depth of road material as to prevent undue action of the frost.'

'The softening of the road-bed, by water retained upon it, permits the stones to settle unequally and become displaced, one end sinking and the other rising, the frost heaving and loosening the mass, and aiding the operation, until the road material becomes generally deranged and imperfect. The method of sub-drainage described, and the depth and form of road materials used, are deemed sufficient to obviate this difficulty in all ordinary cases.' * * * 'The foundation stones, in any upward movement they may be supposed to be subject to, will be met by the resistance of the upper (paved) course which must rise with them in a considerable mass, unless that course is broken up or displaced by some more than ordinary usage or service.'

This was said more especially with reference to the gravel road. The kind of gravel road proposed, not having been before to much extent—so far as I could learn—adopted or proved, as in the case of the Telford road, it was thought the more necessary—as it was uncertain whether the gravel would prove so firm and compact a body of

material over the foundation, and in aid of the foundation, as MacAdam stone—to give the foundation additional security.*

The bottom layer of stones had another advantage, which was that it admitted of using a considerable portion of inferior stones, as it was not necessary that the stones in this layer should be of so good a quality as those in the paving course.

Upon the completion of the paving course, the gravel was deposited on the top, and the road was rolled and finished in the manner that will be more fully described hereafter.

The bottom layer of stones was omitted in the Telford sample, following, in this case, the general plan upon which such roads had heretofore been constructed—that of a single paved course, surmounted with the ordinary MacAdam stone.

The broken stone on the top of the Telford pavement, and also the last five inches on top of the MacAdam road, were from the hard boulder stones of the Park; the first ten inches of the bottom of the latter road being from the less durable gniess rock obtained in excavating for the roadways and other works of the Park.

After the samples were completed, and some facts developed as to their cost, and other particulars, it was decided, on the ground of economy, to reduce the depth of the road material in the continuance of the work, and this left no longer in force the principal reason for adding, in the case of the gravel roads, the layer of stones below the paving course, viz: that of giving the additional depth, &c. It would not have been desirable to compose the bottoming of two courses of stone for the modified depth of materials adopted, inasmuch as both courses would have been lighter, and composed of smaller stones, than would be expedient. The question of cost was an important one, and it was thought best to yield to it, (though there was no doubt of the utility of the depth of material first used,) so far as to restrict the roads next constructed to a depth of about twelve inches.

These three samples have formed a part of the "east drive" of the Park for seven years past, and have remained firm, and preserved a remarkably even surface, under all changes of temperature and wea-

* The only instances of similar gravel roads that had come under my observation previous to this time, were two specimens that I had built on private grounds; the one in the District of Columbia, and the other in Westchester county in this State. The first road had been in use about three years, and I had received very favorable accounts of it; the other was built for my own use, and had not been so long under service.

ther, and under constant service. The sample of gravel road, in particular, has given most satisfactory results.

In recommending the gravel road previous to the completion of the samples, I had stated—

'1st. That a gravel road is best adapted to Park purposes, being the easiest and most agreeable kind of road for both carriages and horses.

'2d. That it is the cheapest as to first cost, and can be kept in repair at an equal, if not less cost, than any other equally satisfactory road.'

These views were expressed after a careful investigation of the subject, and some previous experience, and although not immediately adopted, they have been fully sustained by the ultimate results, as will be seen in the further description of the roads of the Park.

The relative cost of the samples—the details of drainage, silt basins, gutters, &c., being common to all—was about as follows:

Gravel road	1·
Telford road	1·50
MacAdam road	1·75

Omitting from the estimate the bottom layer of stone in the gravel road, and allowing for the reduction of the depth of the Telford and MacAdam roads in about the same proportion, (as was afterwards the case,) gave the following results:

Gravel road	1·
Telford road	1·65
MacAdam road	1·70

The MacAdam stone used in the Telford and MacAdam samples were broken by hand, but a proposal having been made during the progress of the work (which was afterwards accepted) to break the stones by a machine, at a reduced cost, the above estimates of relative cost have been made by using the data of machine-broken stone.

In proceeding with the construction of the Park roads in 1859, the MacAdam and Telford methods were mainly followed during that year. The depth of road material was reduced, as before stated, to about twelve inches. About 7000 feet of MacAdam road and 6000 feet of Telford road were built during the year. The MacAdam road had, as a first layer, a depth of broken gniess stone of 7 inches, with a top layer of 5 inches of the harder boulder stone. The Telford road, in nearly equal portions, was composed (above the pavement), in the one case,

of the hard boulder stone, and in the other of 2 to 3 inches of the gniess stone, surmounted with 3 to 4 inches of the boulder stone.

About 3000 feet of road that was commenced on the Telford plan was modified (owing to circumstances not within the control of the engineer) after the paved foundation was laid, and 2 to 3 inches of broken gniess stone deposited on it, *by substituting in the place of the superior hard broken stone, as had been intended, a light layer of gravel.* The combination of broken stone and gravel was not found to work well. The gravel was surfaced and partially intermixed with limestone chips and stone dust—(refuse from limekiln quarries and detritus resulting from the breaking of large quantities of MacAdam stone,)—and was very thoroughly rolled, but from the want of homogeniety in the broken stone and gravel, a proper bond or union of the two did not take place, and a tendency of the gravel layer to separate and peal off from the stone below was exhibited soon after the road was brought into use. This was especially the case in wet weather, the surface gravel being removed in the form of large flakes by the action of wheels and horses' feet. This portion of road was the least satisfactory (until subsequently remedied) of any of the kinds built, and the practice was not continued.

During the following year, 1860, being the second year that the samples of road had been in partial use, about 2000 feet of Telford road was constructed, and the further extension of both the Telford and the MacAdam roads was thereafter discontinued.

The public use of the sample of gravel road had demonstrated, in the meantime, the qualities claimed for it, and developed a clear preference, on the part of the citizens of New York, for that kind of road. It was evident that they would be satisfied with no other of the tried forms, however perfect and complete they might be made.

During this year, about one mile of gravel road was commenced and mainly completed. The plan was the same as that of the first sample, with the exception that the bottom layer of stone, before mentioned, was omitted, and the depth of road material reduced to about twelve inches. Upon this plan, about half a mile in addition was subsequently constructed, *i. e.*, with the Telford pavement as a base, when the plan was further modified, for purposes of economy, by substituting for the pavement a mere deposit of rubble stones, and with this latter modification, gravel roads were thereafter exclusively adopted for the remainder of the work. [See Plate II.]

The following statement shows the total length of the Park (car-

riage) roads, the lengths of the different kinds of road, and the different widths:

KINDS OF ROAD.

		Miles.	Feet.
MacAdam Road.	Material all of broken stone	1	2,434
Telford Road.	Sub-pavement, with broken stone on top	1	1,684
———	Sub-pavement, with a layer of broken stone intermixed with a top layer of gravel		3,038
Gravel Road.	Sub-pavement, with gravel on top	1	1,070
Do.	Quarry rubble-stone bottom (not paved) with gravel on top	4*	5,145
	Total	9	2,811

LENGTH OF ROADS OF DIFFERENT WIDTHS.

Widths.	Miles.	Feet.
55 to 60 feet	1	1,795
50 to 55 "	0	2,491
40 to 45 "	3	2,206
30 to 33 "	4	158
16 to 25 "	0	1,441
Total	9	2,811

With this general reference to the subject, I proceed to a more full and detailed description of plans and materials of construction.

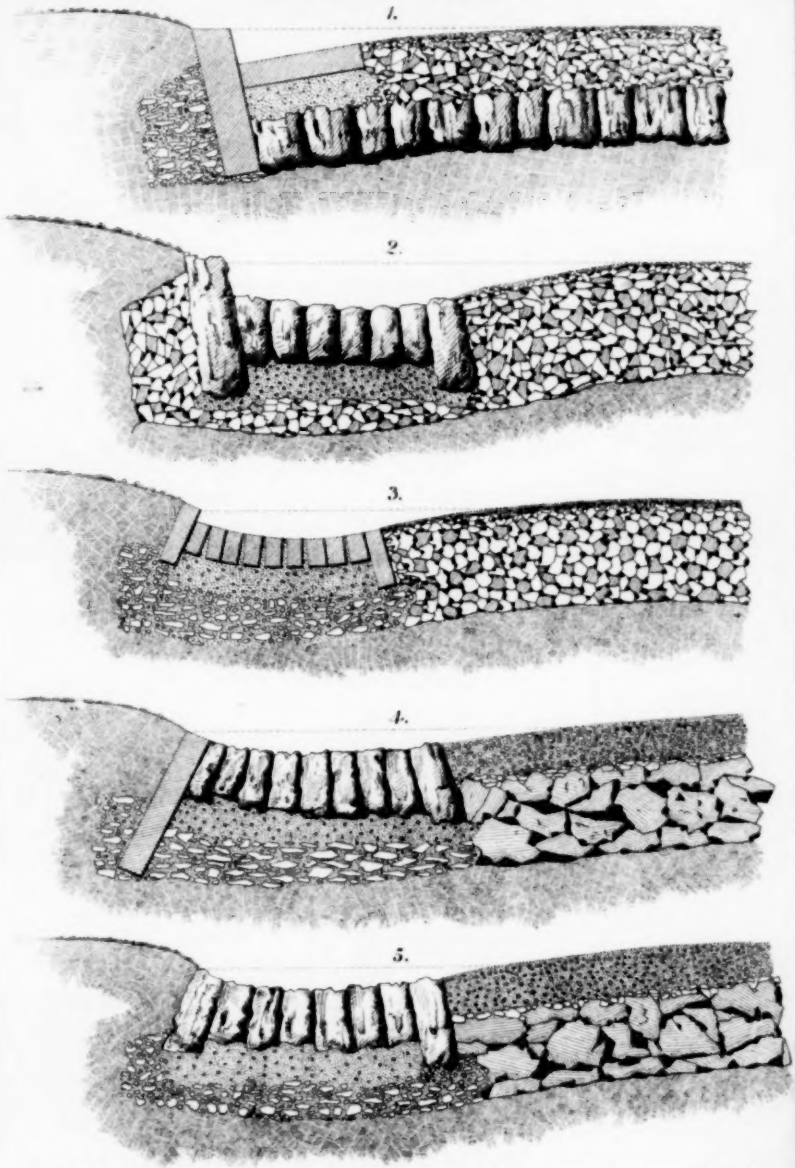
(To be continued.)

NOTE.—Typographical corrections to Chapter I:

Page 101, twelfth line from top, "old" for *odd*.
" 102, twenty-second line from top, "of" for *on*.
" 103, twelfth line from top, "one" for *on*.
" 104, seventh line from bottom, "engineers" for *engineer*.
" 106, second line from bottom, "specialty" for *speciality*.
" 106, bottom line, transpose *quality* and *quantity*.
" 107, seventh line from top, "round" for *rounds*.

* Of this, about two-thirds of a mile was finished with coarse-screened gravel which will be further mentioned hereafter

ROAD GUTTERS

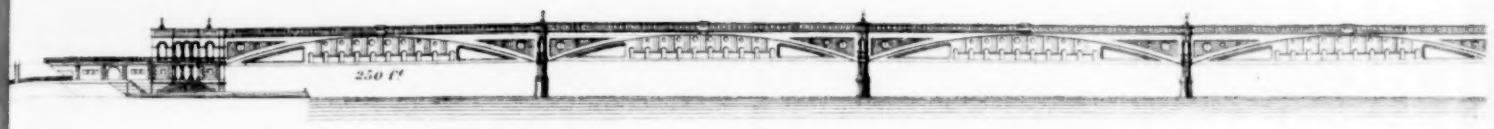


Road No 1. 15 deep of Telford pavement and Mc Adam stone. No 2. 15 of Mc Adam stone, No 3. 13 of Mc Adam stone. Nos 4 & 5. 11 of rubble stone and 5½ of gravel.

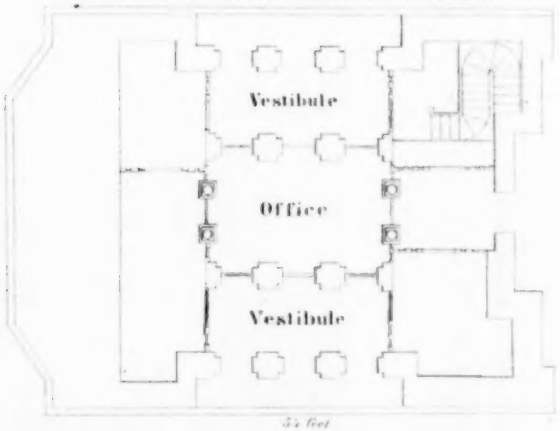
Gutter No 1 dressed blue stone. No 2 rough shaped quarry or field stone curb and cobble stones. No 3. Brick gutter. No 4 blue stone curb and rough shaped quarry stone gutter. No 5 all quarry Stones rough shaped.

Scale ½ inch to 1 foot.

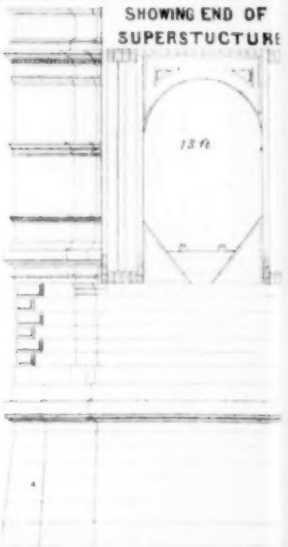
H.P. Smith, del.



PLAN OF LOWER STORY EASTERN ABUTMENT.

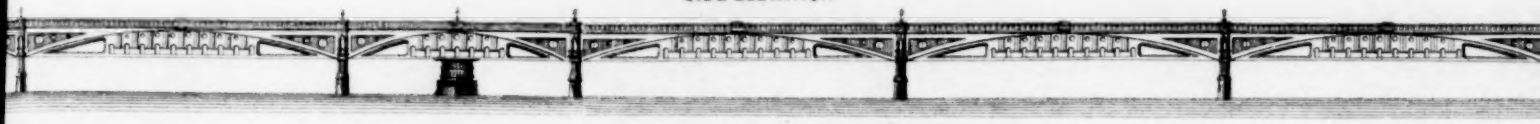


ELEVATION OF WESTERN END OF
SHOWING END OF
SUPERSTUCTURE

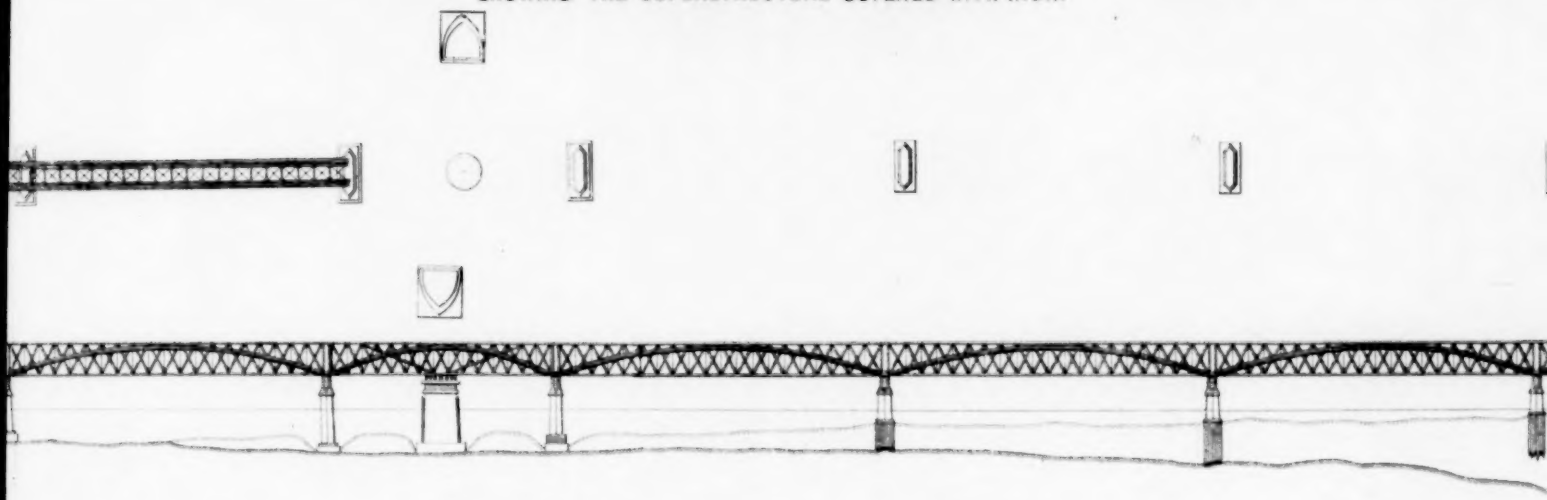


FOUNDATION

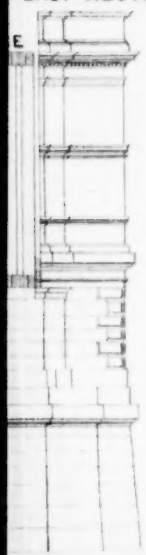
SIDE ELEVATION



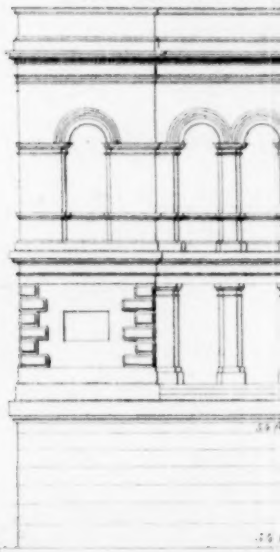
SHOWING THE SUPERSTRUCTURE COVERED WITH IRON.



EAST ABUTMENT



SIDE ELEVATION W



SUSQUEHANNA BRIDGE

AT

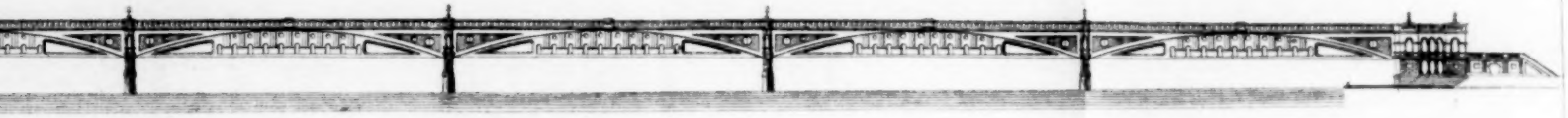
HAVRE DE GRACE

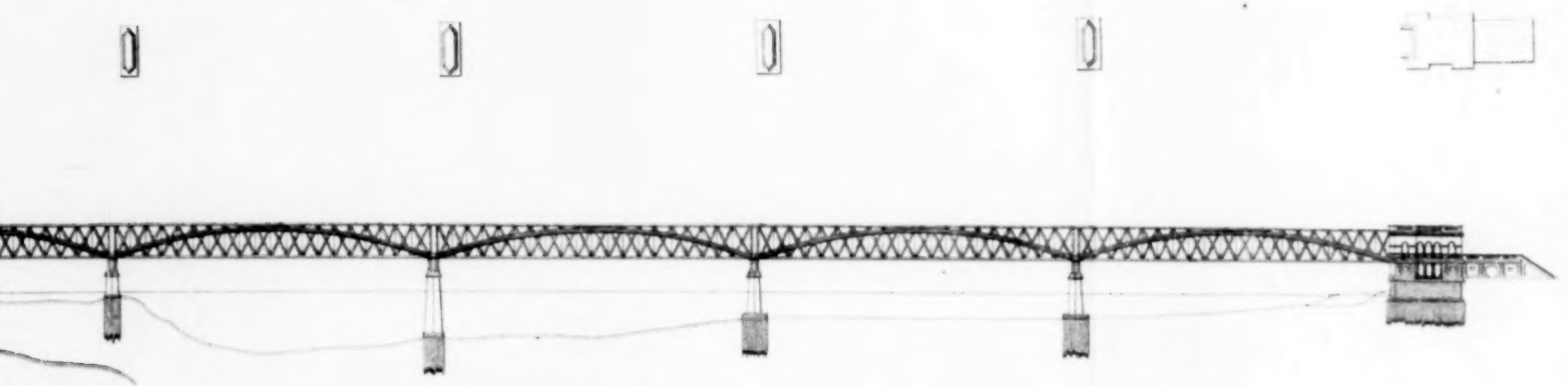
MARYLAND.

PLAN & ELEVATION.

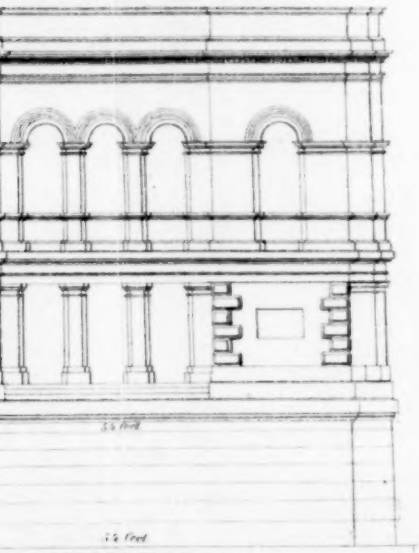
Ja.s M.c Grigan Lith. Philad.a

FOUND

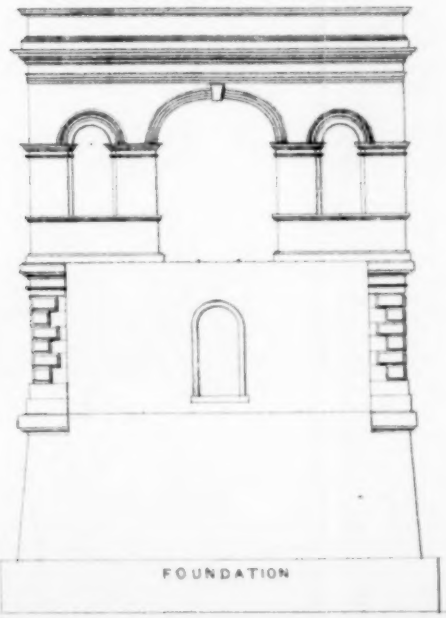




EVATION WESTERN ABUTMENT



END ELEVATION OF ABUTMENTS



THE SUSQUEHANNA BRIDGE,

ON THE PHILADELPHIA, WILMINGTON AND BALTIMORE R. R.

Designed by GEORGE A. PARKER, C.E.

IN fulfillment of the promise made to our readers at the beginning of the year, we now present the first of a series of papers containing a full, detailed, and illustrated description of the engineering work named above. Desiring to make this account as complete as possible, we have thought it well to begin with a preliminary Report, prepared by Mr. Parker, for the information of the Directors and Managers of the road, which has never before been published, and which contains many matters of interest to the engineering community. In addition to the topographical chart alluded to in this report, we subjoin a plate, showing the ground-plan of the bridge, its present condition, and its proposed form when covered with a sheet-iron casing, together with elevations of the abutments.

These drawings are intended simply to furnish a *coup d'oeil* of the entire work, as full working drawings of the several parts will be given in future.

Having premised thus much, we proceed to quote the Report just mentioned.

ENG. OFFICE SUSQUEHANNA BRIDGE, P. W. & B. R. R.,
April 15*th*, 1863.

To S. M. FELTON, Esq.,
President P. W. and B. R. R. Co.

Dear Sir: In reply to your late communication in relation to the Susquehanna Bridge, I beg leave to present the following

REPORT.

The great railway thoroughfare between the North and South is broken by the Susquehanna River at Havre-de-Grace, one mile above the Chesapeake Bay, and four below the head of navigation and tide-water.

This interruption to travel between the political and commercial centres of the country, though partially relieved by a ferry of the greatest excellence, has been long felt to be a serious public evil. Whether it could be obviated by a bridge was for many years a

question of great interest with the transportation companies particularly concerned, with the public, and with persons of science who had given it attention. The engineering difficulties were known to be great—they might be insuperable. In 1854, however, after much preliminary examination, an attempt at the construction of a bridge was made in earnest, but circumstances were such in the following year, that the undertaking, for the time, was abandoned. In the spring of last year, 1862, it was thought necessary to take further steps in the matter, and the undersigned was desired to make such professional suggestions as seemed suitable. After reflection, aided by the recollections of former examinations, an outline of a plan of a bridge was prepared and recommended for so much of trial as was possible during the current season. It was thought that the pier most difficult to construct, and most exposed,—the third one, according to the plan, from the eastern shore,—might be built during the summer and fall, and be fully tested during the succeeding winter and spring. It was determined to act upon the suggestion, but not till after it had become too late to hope for the completion of the pier before winter. Nothing more was undertaken, therefore, than the construction of its foundations, which were completed on the 11th of October. There being enough of the season left for the building of a pier in the shallow water, after some hesitation it was concluded to build the fourth one from the shore, where the depth was but eight feet, and the difficulties and risks comparatively slight. The foundations were completed on the 29th of October, and the iron caisson, within which it had been decided to construct the masonry, secured upon them in two days thereafter. On the 28th of November, the masonry was finished to the height of seven feet above ordinary high water. The work of the season then closed. An open winter set in, which has been succeeded by a spring of uncommon mildness. Our work, therefore, has been subjected to none of the tests that had been looked for. There have been no large accumulations of ice at the mouth of the Susquehanna, nor the usual freshets. So far, therefore, not much more has been demonstrated, practically, than the methods used of forming the pile foundations, and constructing solid masonry in ordinary depths of water.

Whether to use the coming season in finishing the experiment with pier three, and waiting for the further tests of another winter, or, accepting the hazards, to adopt definitively the entire plan which has been outlined (if no better offers), and to proceed in its execution

vigorously, is now the question for consideration and settlement. If there were no urgency in the case, the first course might be reckoned the only prudent one; it is but too well known that the demand for this bridge has now become so great, that it may be reasonably questioned whether it will be satisfied with so deliberate a mode of proceeding, if the other prompter course gives even a moderate promise of ultimate success.

To say of any plan of this sort, that it has been prepared with care and deliberation, is but a small recommendation, and the fact that the present one is the result of several years of minute and systematic investigation, made under an almost painful pressure of responsibility, will not therefore be urged as a merit. It must carry with it its own evidences of truth and reasonableness, or it must be rejected, of course. But against casualties incident to construction, it will not be expected that it can furnish absolute guarantees. No scheme of engineering, involving new and untried methods of dealing with natural forces, can do this. It is only by taking advantage of nature's blind side that we prevail against her at any time; and this advantage is dependent upon chance, never at our command, but to be patiently waited for. There is never security from elemental irregularities. Floods, destructive of the costly preparations of months, will come out of season and contrary to normal habits; and the best contrived machinery will fail, inopportunely and disastrously sometimes, in consequence of the bad faith or unskillfulness of artisans. But these contingencies never can be impracticable elements, if their possible cost is not inordinate, and out of proportion. In a succession of seasons, surely some will be found to be propitious and sufficient, and it would be preposterous to expect, at this period, and in this country, a mechanical failure to be repeated on account of imperfect workmanship. Improvements never fail to follow primary inventions that contain a successful principle. These chances of accident, therefore, do not enter into the question of practicability, when their cost is within admissable limits.

What has been devised for this work is believed to be demonstrable scientifically, the commercial element belonging to the case having therein its full valuation, but it is offered, nevertheless, under the conviction that it is not, and cannot be, altogether free from the doubt that always must surround projects of similar nature. Mr. Brunel, while at once the most adventurous and the most invariably

successful of modern engineers, rarely reckoned beforehand upon the unqualified success of any of his schemes. In his report upon the Victoria Bridge at Montreal, made near the close of his life, he observed, with an impressiveness only to be understood by an engineer: "Few of the great difficulties in engineering, resulting from the operations of natural causes, can be entirely overcome, or the result rendered positively certain by any amount of skill or at any cost. The success is at best a question of degree, and what is called certainty, a mere calculation of probabilities; and a certain amount of risk, more or less, still remains, and while this is a strong argument against incurring excessive cost in the execution of a work which, after all, can never insure certainty, it is also necessary to have it in mind, when considering plans which, speaking in general terms, have been found hitherto to succeed,—it is necessary to examine into the degree of that success, and to consider what value has been attached to the amount of risk still remaining in the examples serving as precedents, and what amount of risk it is wise or profitable to run in the particular case under consideration."

And others as well as Mr. Brunel, when compelled by professional duty to assume the responsibility of inaugurating new enterprises of great cost and public importance, have felt, in perhaps equal measure, this pressure of overhanging doubt. Smeaton had misgivings of the Eddystone during the whole progress of its construction, and never once felt sure of its stability till, with his own eyes, he saw it vibrate in a storm. It was only when he knew it would bend and recover that he was sure it would not break. The Menai Bridge was a subject of doubt and misgiving up to the very moment of its ultimate trial. Telford could not be persuaded of its entire success, notwithstanding that his plans had met beforehand every scientific test, till the actual trial had made doubt no longer possible.

These are instances, after all, of doubts that were altogether fallacious, and therefore should not, perhaps, be discouraging. We cannot have the advantage of the skill of any of these eminent men, but our work may certainly expect to obtain the full advantage of any recent improvement in the general science of engineering, and there is no presumption in saying that this is very considerable. The public works of this country and Europe, executed within the last few years, are rife with improvements of all sorts.

The situation in which it is proposed to place the bridge at the Susquehanna, is, as has been stated, one of peculiar difficulty, but the

better these difficulties come to be understood, the less formidable do they appear. They consist principally in the unusual depths of water, the unstable nature of some part of the bottom, and the violence of the currents in freshets, and when charged with accumulations of ice.

The site was fixed in 1853, after a most careful hydrographic survey had determined, that it was the best to be found within the geographical limits which the supposed exigencies of the great thoroughfare, to which the bridge was to be an adjunct, made available. These limits covered only that portion of the river lying between its mouth and the head of Watson's Island.

The choice of exact position lay between three principal routes, which are shown in the accompanying plan and profiles. The southernly route was open to the objection of deeper water, greater difficulty in securing foundations, and more length than was found upon either of the others. The upper one involved a practical division of the bridge into two divergent parts, joined together by a curved embankment over the island. The middle route, however, was not finally selected till after the fullest consideration and most elaborate comparison of relative advantages and disadvantages.

The axis of the position is that of the present location of the P. W. and B. R.R., extended over the river from the eastern bank. It terminates 1600 feet north of the ferry, and is brought in connection with the southern division of the railway by a change of the latter, beginning 3300 feet west of the Havre-de-Grace station.

The river debouches nearly a mile below, though it usually has the appearance of an arm of the bay till it meets the rapids, four miles above. Within these limits it is a basin, having a fall of only two inches from one end to the other. It is divided by an island about one mile in length and five hundred feet wide, which, at the upper end, is composed of high solid rock, protecting it from the wear of the stream, and on the south has a bar projecting downwards nine hundred feet. This bar is crossed by the bridge line near its lower extremity, the river being there divided into two channels. The shores below, upon both sides, are low and quite uniform out to the bay, but around the island they are crooked and higher, and in some places rocky. Above, they are very steep and even mountainous, and nearly everywhere of primitive rock. The tide ebbs and flows here from two to three feet.

The currents are nearly vertical to the line of the bridge, and in

summer have not generally a velocity at the surface of more than a mile and a half per hour. It is somewhat remarkable, that, under certain conditions of the tide, they increase in force towards the bottom. Except in freshets, however, they do not acquire sufficient force to disturb the bed of the stream. Then they become violent, and changes of greater or less magnitude invariably result from their action. In extreme cases, the water at the centre of the channel has been known to move at the rate of twelve miles to the hour—more rapidly than it ever moves in the Missouri or Mississippi. No considerable changes in the normal directions of the currents occur, except when they are diverted by the ice. The ice phenomena here, therefore, become of importance, and require a particular description, a special interest attaching to them beside that merely practical, from the fact that they are the main cause of the prevailing doubts about the practicability of the bridge.

As was stated, the first five miles of the river are, in effect, a basin, essentially under the tidal influence of the Chesapeake Bay. At the mouth, and extending for miles into the bay, there is but a thread of a channel, near the western shore—contracted and sinuous—affording passage for vessels of only nine feet draft. The wash of the stream has deposited here a bar of alluvium, reaching almost to the surface. This basin is not often frozen over deeply, nor ever, till the water has been dammed at the shallows below by the ice. Until this thaws, or is artificially broken up, no movement of the sheet upon the basin can possibly take place; and when one mass thaws, the other necessarily does, removing thereby whatever of danger it might contain. It does happen, however, that the process of dissolution is arrested by intense cold, at times when there may be a steady back-set from the bay, and then the "slush" and broken floating ice unite, causing an excessive rise in the river. If the cold weather then continues, "packing" takes place on the shallows, and extends back to the foot of the rapids. During this process, the currents take eccentric courses, often directly or diagonally across the stream, and if at such times there be a large increase in the flow from above, these currents, charged with broken ice in masses of great depth, look extremely formidable, though, under the circumstances, they really are not so in any degree corresponding to their appearance, as they consume the most of their momentum in their movements against each other. But they cause jams and ice hummocks at different points in the river, and occasionally dam the water at the head of Watson's Island so effectually, as to flood the

town of Port Deposit, two miles above. The rapidly accumulating force of the stream, however, in a few hours, demolishes these obstructions, and reduces the level to the ordinary high water limits. With the ice in the jammed condition which has been described, continued frost is very sure to result in the solidification of the whole mass within the basin. In the winter of 1851–52 a jam occurred which had exactly that result, and a track was built over the river, upon which trains passed for several weeks. In this condition the ice never moves in a mass. With the progress of the season it gradually "rots," disintegrates, and with the first spring floods, moves harmlessly into the bay.

The ice above never passes the lower rapids till the mouth of the river is substantially clear. It then appears too late in the season for severe frosts, and always in small broken masses. These in great freshets are borne down into the bay with immense violence, but, detached as they are, and having no tendency to aggregate, they are like floating logs, not much more powerful than the water itself.

A line of piers stretched across the river undoubtedly may be expected to somewhat change its *regimé*. A sheet of ice covering the whole area of the basin, will naturally break off when melting at the line of obstruction, leaving the piers exposed to the pressure of what remains. The exact mechanical power of such a mass it is not easy to calculate. Under certain circumstances it may be considerable, but as it can never be cumulative, it is easy enough to find its extreme limit. The relation of the force to the weight will be that of the fall to the length. Thus: the length of the sheet of ice being 25,000 feet, its width is 3300 feet, the difference of level between its upper and lower ends 2 feet, its average thickness 1 foot, and its weight per cubic foot 55 pounds, the whole weight will be 4,537,500,000 pounds, and the whole pressure 363,000 pounds, or about 16 tons to a pier. This must be the maximum while the ice remains together. Its effect would, of course, be imperceptible upon a pier having a weight over the line of impact, exceeding three hundred tons. In a rapid thaw it might occur that the sheet within the eastern channel would break off at the head of Watson's Island, and pass out between the piers in a partially melted state, leaving all above and west of it unbroken. The remaining mass, disintegrating, immediately afterwards, would allow of the possibility of somewhat large masses of "rotten" ice passing down through the opened channel against the intervening piers. But these could not exceed 600 feet square, nor a foot in

thickness. The length of the plane of descent might be 4000 feet, and the whole fall 6 inches. Supposing them to move with the water, their greatest velocity would be 5·67 feet per second, and their momentum 93,600 pounds. One-half of this, say 47 tons, might possibly strike a single pier, and if that should happen to be the deep water pier, the pressure of the water and ice together, upon that pier, would be 110 tons—about the one-twelfth part of its inertia.

The bed of the river, on examining it, after reopening the question of building the bridge, last year, appeared to be not much altered at the positions which had been subject to particular observations in 1853, except at the bar, and on the lower shoals, where it was found that the current had silted up the bottom from one to three feet. The profiles referred to, show in detail the slight changes discovered at the line of the bridge. At the points where the soundings were taken, the bottom was bored wherever it was penetrable. For a distance of 1100 feet from the western bank it is shelving rock, with here and there a patch of sand two or three feet deep. East of that it has, first, the usual stratum of river sediment, one to three feet thick, and next a sandy alluvium varying from two to ten feet in thickness, and below this a layer of nearly pure gravel and sand resting upon the primitive ledges of granite. The earthy formation is undoubtedly a deposit of the detritus of the stream, the law governing delta formation being plainly visible in the stratification. As the original mouth of the river—between the Capes of the Chesapeake, perhaps—silted up and receded the purely mineral matter, borne along with the water, settled upon the organic surface left by the attrition of the currents, and on that have subsided the lighter *débris*, in the order of their density. The depth of the underlying rock has not been ascertained eastward of the bar, but its position is of no practical account, since it is known to be too far down to afford support for a bridge. At a point 25 feet beyond the edge of the eastern channel, it is 65 feet below low-water level, and thence it gradually rises to where it begins to form the bed of the river.

That piers could be built at all the points where the rock was found, was plain enough, though at a cost proportionate to the difficulties—certainly very considerable; but where the rock was too remote to be reached by foundation piles, the practicability of building permanent piers could only be determined by actual experiment—by ascertaining if the lower earth stratum that overlie the rock could sustain the necessary weight. Upon this test, therefore, turned the whole question

of the practicability of the bridge, and no time was lost in applying it as thoroughly as was possible, after commencing the investigations of last year. Experimental piles were driven at every doubtful point. The results were variable, but in the main were so favorable as to permit it to be assumed, provisionally, that pile foundations would be available. The shape of the bridge, that is, the form, number and position of its piers, and its superstructure were then considered with reference to the section of the river, at the highest stage of water, to its channels, to cost—both of money and time—and also to the requirements of the charter. To conform to the law, the bridge, as located, should have a pivot-draw at each channel, with openings of 60 feet. The second draw was evidently an evil to be avoided, and fortunately it was found possible to dispense with it, and practically to comply with the charter also, by so locating a single one as to make it serve for both, after opening a new passage-way for vessels above the line of the bridge.

The main current of the eastern channel was found to be about 250 feet wide, and 42 to 52 feet deep. The currents on the western side of the river, where the deepest water was 30 feet, were not confined to particular channels, their force being pretty evenly divided over a width of 800 to 1000 feet. West of the bar, therefore, there was no concentration of force in the water, to anywhere interfere with building. In the "gut" of the eastern channel it was obviously inexpedient to build, even if it were possible or safe.

The shape of the trunk of the river never changed much, the greatest rise ever known being less than six feet above ordinary low-water.

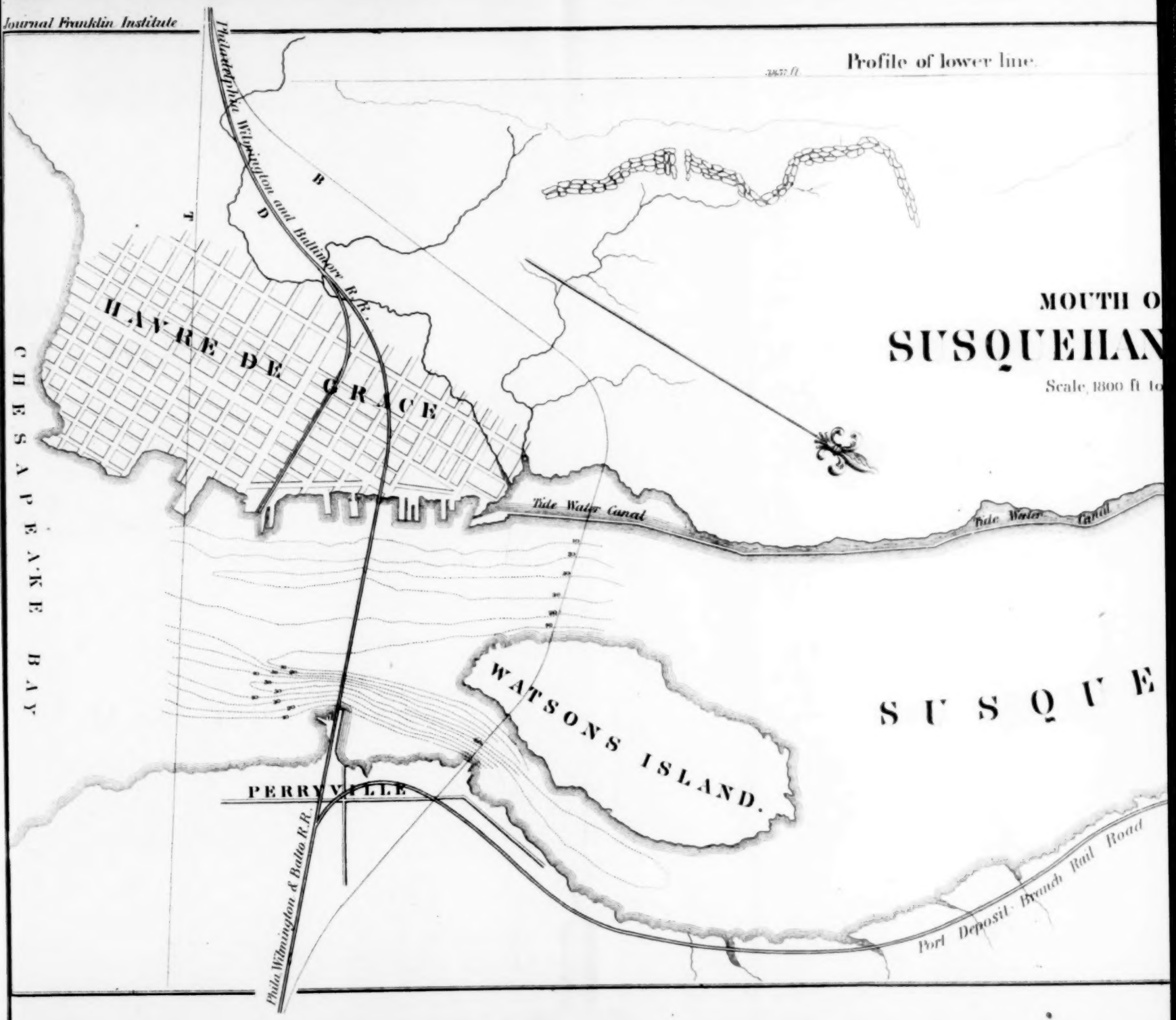
Out of this summary of facts, the first deduction was the necessity for adjusting the bridge to a span of 250 feet over the deep channel. The next was the principle that within that length of span, the total cost, including superstructure, increased inversely with the length; that is, it was found by calculation, using either form of superstructure, that the part of the bridge lying east of the draw, in length about 1800 feet, would cost less, if divided into seven spans of 250 feet each, with seven piers, than the same would cost if divided into nine spans of 200 feet each, with nine piers. No question as to permanent value was here involved, for it was as well known as any other engineering fact, that a superstructure of wood or iron, divided into spans of 250 feet, might be both as strong and as durable as one having smaller divisions.

The timber bridge at Bellows' Falls, in Vermont, upon the line of the Sullivan Railroad, having spans of 250 feet, had been standing since 1850, and had proved as efficient as any of less dimensions, though it had been subject to uncommon trials. The centre deflection, when this bridge was tested by three heavy locomotives, drawing a freight train at a speed of 25 miles to the hour, was nine-tenths of an inch, the permanent set remaining being about one-sixteenth of an inch.*

The advantage to the water-way of these large spans, though not an obvious truth at the first sight, was found to be relatively as great here, where the stream has the unusual width of nearly a mile, and an average depth of more than 22 feet, as in the more common situations of narrower channels and more excessive fluctuations. The general facts pointed to a rigid observance of a primary rule of engineering, restricting obstructions to the flowage to a practical *minimum*, by limiting the number and size of the piers. Provision was to be made for the discharge of all the water of a river of the first class, and the pressure due to increased flow during freshets, must be the same here as it was known to be elsewhere. It had to be considered that in none of the vicissitudes of water flowing in channels, could an increase in volume alone be any reliable index of the quantity in motion, or of its mechanical force. The lower reaches of great rivers were known to be of a nearly invariable section of orifice. The Danube was neither broader nor deeper after receiving the Inn, nor its periodical changes more considerable than those of the Susquehanna. This uniformity of volume under all circumstances had a partial explanation in the main fact, that during floods, and while the swollen rapids were brought even with the connecting planes above and below, submerging the obstructions, which in the common stages operate effectively in neutralizing momentum, a large portion of the particles of water near the rivers' mouth receives the full force due to the total descent of the stream and its affluents. The velocity and pressure were nearly as the whole fall, and the discharge in proportion to the accelerated velocity.

But a more cogent reason for giving to the bays the widest practicable limit, than any to be deduced from these more general facts and considerations, lay in some of the anomalies which the situation dis-

* NOTE.—This bridge was designed and built by Mr. Parker, and was the first timber bridge for a railroad of so long a span, erected in this or any other country. —ED.


Profile of lower line.
MOUTH O
SUSQUEHAN
Scale, 1800 ft to
Philadelphia Wilmington and Baltimore R.R.
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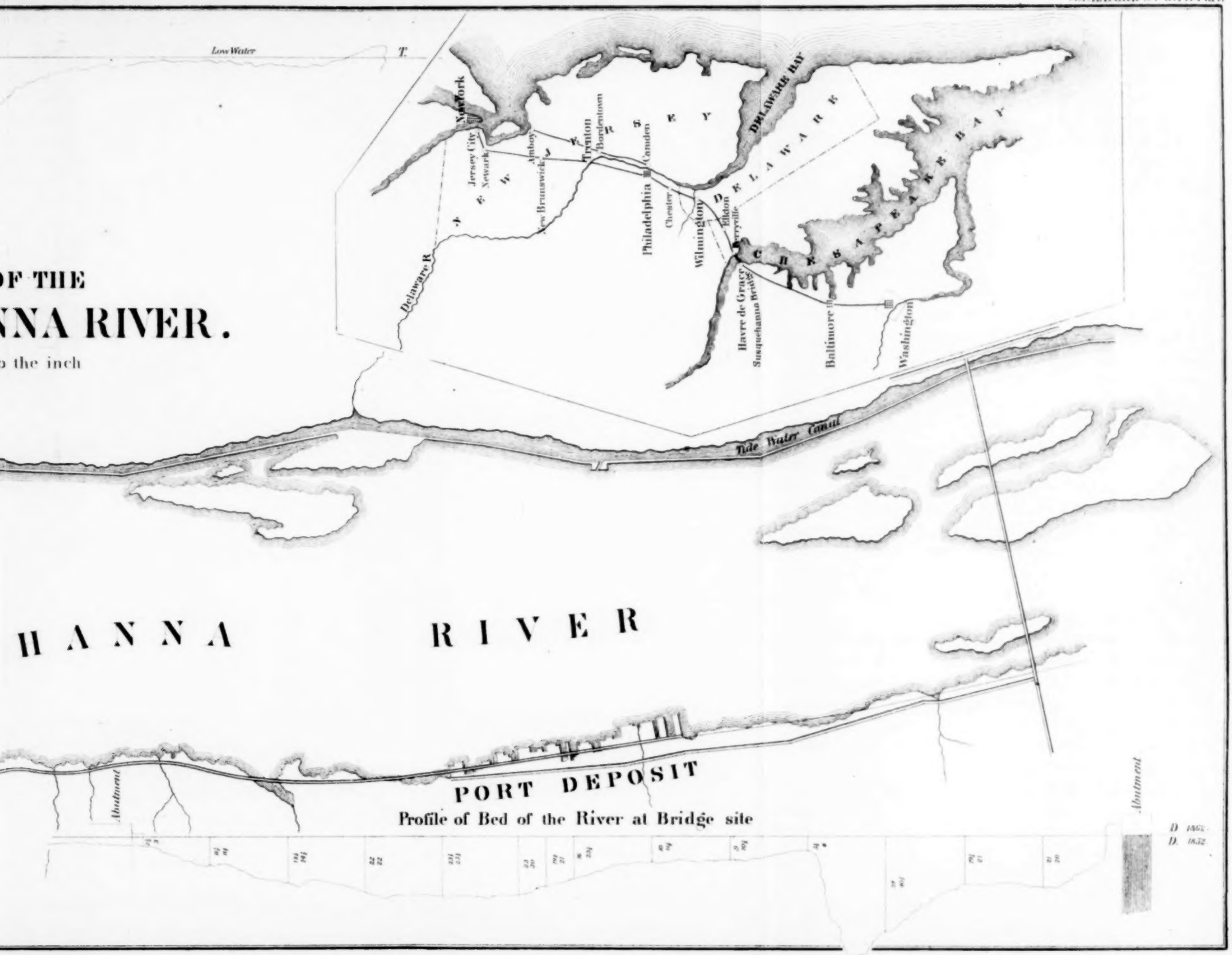
CHESAPEAKE BAY
Tide Water Canal
Tide Water Canal
WATSONS ISLAND.
SUSQUE
PERRYVILLE
Phila Wilmington & Balto R.R.
Port Deposit Branch Rail Road

3857 ft

Profile of lower line.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Havre de Grace
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Baltimore
Washington
DELAWARE BAY
DELAWARE
CHESAPEAKE BAY
Tide Water Canal
HANNA
RIVER
PORT DEPOSIT
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Abutment
Profile of Bed of the River at Bridge site
D 1865
D 1852

covered. For instance, the force of the stream there, upon any theory of calculation thought to be applicable, was that due to a velocity under six miles to the hour, while the measured velocity in the centre of the channels was fully twelve miles to the hour at the surface of the water.

The structure having to be of a strictly utilitarian character, art could claim little more of it than a decency of proportion, and as much of symmetry as could be attained without sacrificing economy.

Upon the whole, it seemed to be best to fix the channel span with strict reference to its shape, and the length of that being 250 feet, to make all the other regular spans the same, placing the draw at the point where it would best answer the double purpose required of it. Laying out the work upon this idea, it was found that twelve complete spans of that length, with a draw of 175 feet, brought the ends of the bridge, where abutments were required, sufficiently within the line of existing and permanent projections from the shores, to secure them amply from any possible wash of the river. The site of every pier was exactly determined, carefully surveyed, and, where practicable, tested by piles, driven by a ram weighing two thousand pounds.

(To be continued.)

ON THE IMPROVEMENT OF RIVERS AND HARBORS THROUGH THEIR DELTA.

By D. S. Howard, Civil Engineer.

Water is so nearly a perfect fluid, that it is influenced by the slightest force, whether at rest or in motion. When at rest, a mild wind, if continued, will create a violent oscillation, in the shape of waves or swells. If in motion in a channel, however smooth, the slightest inequality of resistance on the sides will cause a vibratory motion from side to side, with violence proportioned to the velocity of the current, which will also be the measure of a similar motion between the surface and the bottom of the stream. The length of the vibrations indicate, by proportion, the depth as well as the width of the stream.

A combination of these forces, when sufficiently strong to be observed, produce what are called ripples, in small streams,—in larger ones, rapids. The motions are the same in waters of less velocity;

though the surface be smooth, the thread of the stream vibrates from side to side, and from surface to bed, with the same certainty, and with a force in exact proportion to the velocity of the stream.

These laws are also answerable for the formation of "breakers," when the dead swells of a deep sea approaches the shoal or beach; but we need not carry this general discussion further, as the object of the present writing is to illustrate the laws that govern rivers with a plurality of outlets, such as the Ganges, Nile, Danube, Mississippi, &c., which divide their waters through their delta into two or more streams. These streams are, all in their turn, the main outlet. The shortest will, of necessity, have the greatest velocity of current, which not only calls for the largest share of the debris from the upper waters, but creates greater force in the oscillating motions mentioned, which wear away the banks, and form bars and bays, increasing the delta, and otherwise adding to the length of the current, until the velocity is less than that of some other one of the outlets, when the superiority of outflow will be transferred to the shortest and most direct of the other channels, until the same causes, in the course of time, shall have increased the delta in that direction, and in other ways shall have lengthened the current of the stream, when the next most direct outlet comes in for its turn.

The time required for these changes is determined by the age and extent of the delta, and the specific gravity of the material forming it, which indicates its inclination, and the consequent velocity of water required in its formation.

The heavier the material, the greater the velocity required to carry it through; consequently the heaviest will stop short of the outlet in the bed of the river, until the necessary greater inclination is produced, while the lighter part of the drift is spread upon the overflown banks, raising them, in the same proportion, to the same inclination.

A thorough investigation of these laws to a full realization of them, will point directly to the only successful course to be pursued in the improvement of rivers through their delta.

This is a question, to most engineers, never yet satisfactorily settled. None of the usual appliances on channels with permanent banks can be made successfully, such as dams and locks, dykes, levees, &c.

In addition to the great expense of such structures, on so uncertain a foundation, they have a tendency to favor a larger flow through some other channel, which it is the main object to prevent.

When the largest portion of water is permanently secured to the

channel selected for improvement, the others will gradually fill up and become extinct. Therefore, all the efforts made should be to shorten and enlarge the one we wish to improve, by straightening and removing all obstructions to an easy flow to the outlet.

The straightest channel, through the same extent of delta, will be the shortest, and the shortest will give the greatest velocity to the water, which, with a little assistance, will scour it out to a capacity sufficient to cause the waters of the upper stream to seek the improved channel, for the shortest and easiest way to reach their destination.

No attempt should be made to force the water into the improved channel, which should be constructed with an uniform bed, low enough to require no other force than that of gravity, to bring the water through it. There is no foundation by which any other force can be made available in the deltas of rivers.

The piers or jetteys at the outlet for the harbor, if any be required, should not contract the channel so as to prevent the sea-level from setting as far up the channel as possible, as the velocity of the current is a measure of its length. They should only be fitted to prevent the coast winds from filling the channel with material from the beach. They should extend into water so deep, that no ordinary swell should ever reach the bottom with force enough to disturb it, and only near enough together to prevent the coast winds from getting up a sea between them. Then, if a uniform channel through the outer bar be made, of the same depth as the water inside, and an ample breakwater be placed at a proper distance from the piers, to prevent the direct sea winds from creating swells between them, calculated to precipitate the sediment before it leaves the channel, no deposit of much consequence from the river will stop short of deep water.

The situation of the outlet may be such that but one jettey will be required. When the prevailing winds are coastwise, or a little inclined, and the surface currents correspond, as at the mouth of the San Juan Del Norte, Nicaragua, one jettey on the windward side is better than two, particularly if there be a curve in the coast, forming a fair lee shore, a proper distance from the jettey, which should be extended at right angles, or nearly so, to the prevailing winds, and terminate in deep water.

The length of the jettey should be proportioned to the distance from the lee shore, and so situated as to form a centre for the first motion of an eddy, caused by the winds and current, assisted by the under-tow from the lee shore and the outflow of the river, with the re-

sistance of the jettey, by all which a resultant force will be created, that will scour out a channel along the side of the jettey, and leave all deposits at the end, in a direction determined by these combined forces.

There is but one thing more to complete the permanent improvement of the river and harbor. This is the control of the freshets, by reservoirs at the headwaters, which is sometimes the cheapest way to begin the improvement, for by this means, nearly all the material for bars is left in the bed and on the banks of the upper waters.

The only objection to the reservoir system is the necessary overflowing of land, but this objection is generally more than balanced by rescuing more valuable lands from inundation by freshets, to say nothing about the destruction of other property, and sometimes human lives as well.

A partial control is better than none. Sometimes a very small expense will control a large amount of water; for example, by damming the outlets of small lakes, very common at the headwaters of most large rivers—making the spilling way very narrow and the abutments very high—thus requiring the lakes to rise much higher than usual, without a sufficient discharge to create a freshet. Such reservoirs are very useful, without gates or attendants, or any supervision whatever.

San Juan del Norte, Nicaragua, March 12, 1867.

From the London Engineering, No. 62.

THE FLORIDA AND CUBA CABLE.

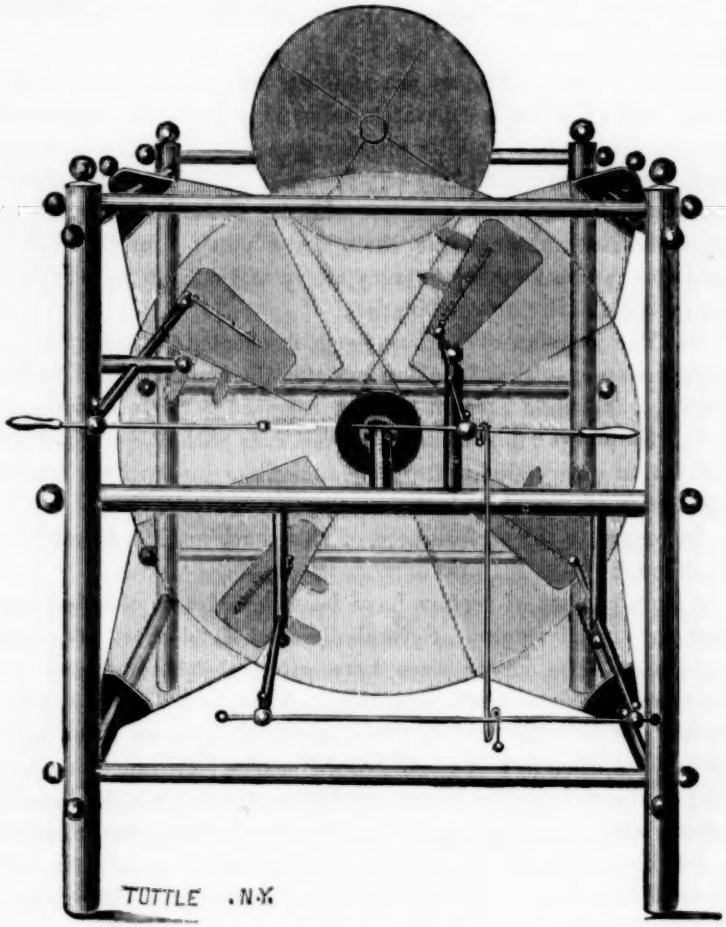
The India Rubber, Gutta-percha and Telegraph Works Company (Messrs. Silver & Co.) are at present manufacturing a cable for submergence between Florida and Cuba. The length of the cable is one hundred and ten miles. The conductor weighs one hundred and seven pounds to the nautical mile, and is insulated with one hundred and seventy pounds of gutta-percha. The core is served with hemp in the usual way, and is covered with twelve No. 9 galvanized iron wires. The complete cable weighs about two tons to the nautical mile. This is, we think, the first instance where a cable of anything like this length, and having a gutta-percha core, has had the core manufactured and the iron wires applied on the same premises, thus saving the risk attendant on the transport of the core from one factory to another. The small weight of this cable is another instance showing that the Americans are still learning the lessons as to the life of cables, which have been learnt at such cost by our own large submarine telegraph companies.

Mechanics, Physics and Chemistry.

AN IMPROVED FORM OF THE HOLTZ MACHINE.

By Charles T. Chester, Esq.

We give below a drawing of a Holtz Machine which has just been constructed and put in operation most successfully, by Mr. C. T.



Chester, of the firm of C. T. & J. N. Chester, in New York, well known as extensive manufacturers of all apparatus used in telegraphy.

The novel features in this machine, and those which give it special efficiency and convenience in use, are the following:

1st. With the exception of the rotating plate and sectors, the whole instrument is made of vulcanite and brass.

By this means, every part may be made with perfect precision and great strength and firmness; while in the original instrument, many parts being made of glass rods and of wood, there was great want of accuracy in adjustment, and that general *shackly* condition inseparable from the use (in a complicated machine) of such a material as glass, which is at once easy to break and difficult to shape into the desired form.

2d. The paper inductors are supported on spear-shaped plates of glass, each of which is separately adjustable as to its distance from the revolving plate and its angular direction, and may be replaced with great facility in making experiments. This is a great advantage over the large and delicate plate with its five openings, used in the original machine, where no change was possible in the individual inductors, and a fresh plate (very costly and difficult to prepare) was required for each new combination.

3d. The junction of various parts is effected by strong-threaded rubber screws, so that in a few minutes the machine can be taken to pieces, or a single portion may be removed without disturbing the rest. So far was this from being the case with the original instrument, that a very slight alteration sometimes involved the entire disconnection of the whole instrument.

In regard to the performance of this machine, Mr. Chester writes as follows:

"Only one set of sectors have been tested with this instrument, with very good results. Several different sized tubes are used for condensers—the larger sizes have given the best results, as the machine develops much quantity. Very voluminous sparks are flashed between the buttons when separated between three and four inches, but when in best condition, the sparks leave one of the buttons and spring to a portion of the condenser, five to six inches, and alternating with these long sparks in air, many flashes between seven and eight inches, spring within the condensers or upon their surface. Several new sectors are in course of preparation, and will be compared with the originals. No insulation has seemed necessary since the first. No weather has thus far prevented the operation of the machine.

"The original Holtz machine, which was in my possession for some

time, was so arranged as only to work by uniting the two positive and the two negative collectors. This arrangement gives a good result with this American machine, but it is far exceeded in brilliancy by the connection of three collectors against one. The machine seems capable of a much higher development."

PROPOSED CHANGES IN THE HOLTZ MACHINE.

We translate from the *Comptes Rendus*, of January 7th, a portion of the remarks made by M. de Parville at a meeting of the Academy of Sciences held on that date.

"I now have the honor of submitting to the Academy, a new arrangement of electric generator which I have just devised, but for which I ask permission to date from to-day."

"In all apparatus before described—in the machine of M. Holtz—in the electrophorus of M. Piche, the disc induces equal quantities of electricity in equal times, and the discharges being continuous, the tension remains the same after each turn of the handle."

"When the inductor polarizes the electricity imperfectly, or when the hygometric condition of the air hastens the loss, the machine, after a certain time, will not work, or, in fact, in all cases the tension on the collectors decreases if you do not renew the discharge."

"I propose to make an electrophorus with inverse properties, that is to say, working with a substance which is partially isolating, and in which the tension, instead of diminishing, augments proportionally to the turns of the wheel. At each revolution of the disc, the machine multiplies its first charge, and the tension is only limited by the loss which results from different parts which diffuse electricity in damp air, agreeing very nearly with Coulomb's law."

"This is my arrangement:

"A disc of material, which is not a good conductor, is adjusted to turn on an isolated axle, before two half-plates, which are distinct and separate, allowing the axis of rotation to pass between them. Before the disc are placed comb collectors terminating in balls which collect different kinds of electricity."

"The plates of isolating substance, which are partly covered by conducting plates, serve as inducing elements, as the stationary plate

of M. Holtz or the sectors of M. Piche. Each of them has in its centre, and perpendicular to its plane, a metallic handle terminating in a comb. At a short distance from these combs, and supported on the same prolonged axis of rotation, turns a second disc, similar to the first, before two different plates, equally distinct and separate. Finally, the balls of the collectors are respectively connected by metallic wires with the two last plates."

"It is only necessary to give a rapid rotary motion to the axle of the machine; when it is so arranged a continuous jet of powerful electricity should continually flash between the poles of the collectors."

"You can electrify one of the inductors. However, according to Faraday's theory, the two inductors finally electrify themselves directly, by the intervention of the middle moving part. The movable disc receives contrary electricity, and the collectors are charged."

A mathematical discussion of the subject, which we do not think likely to interest our readers, here follows, after which—

"It is then seen that in this condition the inductor would not fail to polarize the electricity, the multiplying discs would be constructed of partially isolated material, the machine would not be less charged, and the longer it was worked the better it would become. The experiments which we have made with an imperfect model give us these results."

Some remarks of a controversial rather than scientific character, here follow, which we do not think it worth while to reprint.

ED.

AN IMPORTANT ADJUNCT TO THE INDUCTION COIL.

By HENRY MORTON, Ph. D.

THE use of Leyden batteries with the Induction Coil seems to me not to have received the attention which the subject deserves. The enormous quantity of electric force set in motion by this machine, and the splendid effects produced, (especially in the eyes of the operator, who is moderately near the apparatus,) have probably diverted attention from those means which might be enlisted for yet greater development of these effects.

The requirements of lectures delivered in large buildings have, however, led me to study those means by which the most brilliant effect

possible might be secured to various experiments, and as the results obtained have, to the best of my knowledge, never as yet been published, I proceed to put them on record for the benefit of all who may be interested in the subject.

As a starting point, I would remark that, as is well known to all, the introduction of a Leyden jar into the secondary circuit of the Coil, shortens the spark and increases greatly its brightness. This increase of brightness is due to the concentration of the entire discharge into a single and instantaneous spark of intense temperature, as shown in the spectrum investigations of Plucker. It might, therefore, be expected that the light obtained by this discharge would be richer in actinic rays than that developed by the unaided coil, even if its luminous character was (by reason of diffusion in rarified gases, or the like,) but little increased. These actinic rays, however, are exactly those which develop the beautiful phenomenon of fluorescence; hence, we ought, by the addition of a Leyden jar, to increase, in a marked manner, the beauty of experiments in which this fluorescence plays an important part. The first instrument tried with this view, was the Electric Egg of Canary glass, made by Mr. Ritchie, of Boston, and which, within a range of twenty feet, is so beautiful an object, even with the simple current. It was found that the fluorescent light of a rich emerald green from the glass vessel (18 inches in height by 7 inches in diameter) was at least doubled by the use of a jar; though the flame-like discharge within, showed little increase in brightness, suffering, however, a change in color, from peach color to pink, with a diminution of the blue glow on the negative pole.

To secure the action described above, it is necessary to make some break in the circuit beside that in the exhausted vessel; as otherwise, the discharge would take place so readily that the fluid would not accumulate in the jar, and thus acquire volume and concentration.

The above arrangement has, without doubt, been used by many; in fact, I find, on inquiry, that Professors Robert E. Rogers and John F. Frazer, of this city, have both employed it. As, however, I also find others who have not so done, and do *not* find any notice of it even in works treating especially on the Induction Coil, such as Du Moncel's book of 400 pages, (Notice sur l'Appareil d'Induction Electrique de Ruhmkorff,) and Noad's 'Inductiorium' of 109 pages, I have thought it best to give the foregoing description.

The arrangement above recorded, though entirely satisfactory in the case named, is limited in its sphere of application by the reduced

length of the spark. Thus, with the apparatus I possess, whose spark length is 8 inches, no discharge can be obtained in an Aurora tube of 5 feet, when the jar is introduced. So, also, with the longer Geissler tubes, whose spiral passages develop a length of some feet.

To overcome this difficulty, resource was had to the following expedient: Several jars were arranged so as to be charged by cascade. This plan was first devised by Benjamin Franklin, to save labor in charging a large battery, and is mentioned in his Philosophical Essays, as well as by many others who have written since; among whom Mr. Boggs seems first to have pointed out that the spark length was in this way greatly increased. *Silliman's Journal*, II., 7. 418.

In the case of the coil I find, that, while sparks of but one inch are obtained with a single jar in connection, six jars arranged for "cascade" increase the striking distance to 4 inches.

By this means, therefore, the difficulty as to spark length may be overcome, but not with convenience, as few things could be more unwieldy and fragile than such a combination of jars. I had, therefore, resource, at once, to a battery of plates identical in principle with that described by Franklin in the essay before quoted, but differing in detail of construction, and in various appliances.

The simplest way to make such an arrangement is to procure a photographic negative box, capable of holding two dozen 8 by 10 inch plates. (This is the minimum size for an 8-inch coil.) Place in the grooves provided in this box, 8 plates of glass, (8 by 10 inches,) having sheets of tinfoil, 6 by 8 inches, with rounded corners, pasted upon each side. The plates should be equally spaced, and about $\frac{3}{4}$ inch apart. Then connect the adjacent coatings of successive plates by balls of rough paper wrapped with a strip of foil, and pass a copper wire, enclosed in a glass tube, through the lid of the box at each side, so as to make connection with the outside coatings of the extreme plates. These terminal wires being connected with the coil, sparks of $5\frac{1}{2}$ inches are easily procurable, and are characterized by the white light and loud report peculiar to the Leyden jar discharge.

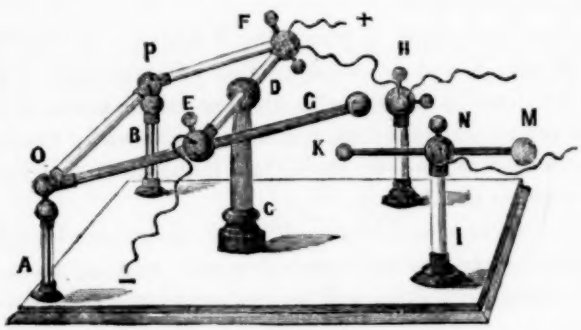
With such an apparatus, all the usual vacuum experiments are easily managed, and the beauty of most, wonderfully increased. Thus the Aurora tube, in place of showing a stream of light half an inch wide, is *filled* throughout its length and diameter of three inches. The large goblets of Canary glass supplied by Mr. Ritchie, for the cascade experiment of Gassiot, eight inches high and six inches across the bowl, in place of shining faintly, with a dark green, almost

invisible, at thirty feet seem so luminous as to be opaque with their own light, like white-hot glass, and give an emerald color, which is even brilliant at a distance of fifty feet.

So with other similar experiments. With the Geissler tubes of small diameter, however, this apparatus produces no improvement, but rather a loss of effect. The small size of the passage seems to occasion a resistance (due to induction in the material of the tube) which it requires time to overcome, and against which, therefore, this instantaneous flash acts at a disadvantage.

To throw the *battery* above described, in and out of connection, and at the same time make the required changes in the continuity of the circuit, the following plan has been found very convenient.

The base-board in the figure represents the top of the box containing the *battery;* A and B represent the terminals of this battery,



being connected with the outside coatings of the extreme plates, by wires inclosed in the supporting tubes. The frame F P O E G, consists of brass rods and balls, F P and O G, and of cross-pieces, P O and F E, of vulcanite or glass, of which F E turns with friction in the wooden upright, C D. By this means the balls, O P, may be put in contact with the battery terminals, as in the cut, or raised from them. The caps H and N, on glass supports, hold wires leading to the apparatus to be exhibited, while the wires from the coil are attached at E and F; F and H are also permanently connected by a flexible wire.

When the ends of the frame are depressed, as in the cut, and the *battery* is consequently in connection, a break in the circuit to the apparatus is introduced, between G and K. This can be regulated as to its amount, by sliding K M through N.

When, however, the connection with the battery is broken, by

raising O P from A B, G comes in contact with K, and the connection between coil and apparatus is rendered perfect.

I find a *battery* of greater surface, more effective with large experiments than that described before. Its construction is, however, identical with the former, except that glass plates eleven by fourteen inches, with tin-foil coatings eight by eleven inches, set one inch apart in a box of the required size, are employed.

There is another point in connection with the coil and Leyden jars, which is of great importance to experimenters in electricity, namely, that all the ordinary experiments in attraction and repulsion, the chime of bells, sportsman and birds, electrical umbrella, orrery, flyer, &c., may be operated with perfect ease, by connecting the apparatus in question with a Leyden jar or battery, and then charging this latter as usual, with the coil; that is, by connecting the outer coating with the negative pole, and throwing sparks from the positive pole at the knob.

This seems so simple a plan, that I hesitate to mention it as a novelty, though I find no word to this effect in any of the many books which describe the experiments that can be performed with the coil, or in the catalogues of manufacturers, who would hardly omit so important a feature, and so strong an inducement to purchasers, if they were aware of the fact.

Others, however, may, like myself, until lately, have been prevented from trying, by the general impression that nothing was to be done in this direction, and if so, will be profited by the suggestion.

From the London Mechanics' Magazine, January, 1866.

ON SOUNDING AND SENSITIVE FLAMES.*

By PROFESSOR TYNDALL.

THE sounding of a hydrogen flame when enclosed within a glass tube was, I believe, first noticed by Dr. Higgins in 1777. The subject has since been investigated by Chladni, De La Rive, Faraday, Wheatstone, Rijke, Sondhauss and Kundt. The action of unisant sounds on flames enclosed in tubes has been investigated by Count Schaffgotsch and myself. The jumping of a naked fish-tail flame in response to musical sounds was first noticed by Professor Lecomte at a musical party in the United States. He made the important observation that the flame

* Read before the Royal Institution of Great Britain, January 18th, 1867.

did not jump until it was near flaring. That his discovery was not further followed up by this learned investigator was probably due to too great a stretch of courtesy on his part towards myself. Last year, while preparing the experiments for one of my "Juvenile Lectures," my late assistant, Mr. Barrett, observed the effect independently; and he afterwards succeeded in illustrating it by some very striking experiments. With a view to the present discourse, and also to the requirements of a forthcoming work on sound, the subject of sounding and sensitive flames has been recently submitted to examination in the laboratory of the Royal Institution. The principal results of the inquiry are embodied in the following abstract:

Pass a steadily-burning candle rapidly through the air, you obtain an indented band of light, while an almost musical sound, heard at the same time, announces the rhythmic character of the motion. If, on the other hand, you blow against a candle flame, the fluttering noise produced indicates a rhythmic action. When a fluttering of the air is produced at the embouchure of an organ-pipe, the resonance of the pipe reinforces that particular pulse of the flutter whose period of vibration coincides with its own, and raises it to a musical sound. When a gas-flame is introduced into an open tube of suitable length and width, the current of air passing over the flame produces such a flutter, which the resonance of the tube exalts to a musical sound. Introducing a gas-flame into this tin tube three feet long, we obtain a rich musical note; introducing it into a tube six feet long, we obtain a note an octave deeper—the pitch of the note depending on the length of the tube; introducing the flame into this third tube, which is fifteen feet long, the sound assumes extraordinary intensity. The vibrations which produce it, are sufficiently powerful to shake the pillars, floor, seats, gallery and the five or six hundred people who occupy the seats and gallery. The flame is sometimes extinguished by its own violence, and ends its peal by an explosion as loud as a pistol shot. The roar of a flame in a chimney is of this character: it is a rude attempt at music. By varying the size of the flame, these tubes may be caused to emit their harmonic sounds.

Passing from large pipes to small ones, we obtain a series of musical notes, which rise in pitch as the tube diminishes in length. This flame, surrounded by a tube 17⅞ inches long, vibrates four hundred and fifty-nine times in a second, while that contained in this tube, 10⅜ inches long, vibrates seven hundred and seventeen times in a second. Owing to the intense heat of the sounding column, these numbers are greater than those corresponding to organ-pipes of the same lengths sounding in air. The vibrations of the flame consist of a series of partial extinctions and revivals of the flame. The singing flame appears continuous; but if the head be moved to and fro, or if an opera-glass, directed to the flame, be caused to move to and fro; or if, after the method of Wheatstone, the flame be regarded in a mirror which is caused to rotate, the images due to the revivals of the flame, are separated from each other, and form a chain of flames of great beauty.

With a longer tube and larger flame, by means of a concave mirror, I can project this chain of flames upon a screen. I first clasp my hand round the end of the tube, so as to prevent the current of air which causes the flutter from passing over the flame. The image of the flame is now steady upon the screen before you. I move the mirror, and you have this continuous luminous band; I withdraw my hand; the current of air passes over the flame, and instantly the band breaks up into a chain of images.

A position can be chosen in the tube at which the flame bursts spontaneously into song. A position may also be chosen where the flame is silent, but at which, if it could only be started, it would continue to sound. It is possible to start such a silent flame by a pitch-pipe, by the syren or by the human voice. It is also possible to cause one flame to effect the musical ignition of another. The sound which starts the flame must be nearly in unison with its own. Both flames must be so near unison as to produce distinct beats.

A flame may be employed to detect sonorous vibrations in air Thus, in front of this resonant case, which supports a large and powerful tuning-fork, I move this bright gas-flame to and fro. A continuous band of light is produced, slightly indented through the friction of the air. The fork is now sounded, and instantly this band breaks up into a series of distinct images of the flame. Approaching the same flame, towards either end of one of our tin tubes, with the sounding flame within it, and causing it to move to and fro, the sonorous vibrations also affect the breaking up of the band of light into a chain of images. In this glass tube, 14 inches long, a flame is sounding; I bring the flat flame of a fish-tail burner over the tube, the broad side of the flame being at right angles to the axis of the tube. The fish-tail flame instantly emits a musical note of the same pitch as that of the singing-flame, but of different quality. Its sound is, in fact, that of a membrane, the part of which it here plays.

Against a broad bat's-wing flame I allow a sheet of air, issuing from a thin slit, to impinge. A musical note is the consequence. The note can be produced by air, or by carbonic acid; but it is produced with greater force and purity by oxygen. The pitch of the note depends on the distance of the slit from the flame. Before you, burns a bright candle-flame; I may shout, clap my hands, sound this whistle, strike this anvil with a hammer or explode a mixture of oxygen and hydrogen. Though sonorous waves pass in each case through the air, the candle is absolutely insensible to the sound; there is no motion of the flame. I now urge from this small blow-pipe a narrow stream of air through the flame of the candle, producing thereby an incipient flutter, and reducing the brightness of the flame. I now sound the whistle; the flame jumps visibly. Matters may be so arranged that when the whistle sounds, the flame shall be either almost restored to its pristine brightness, or that the amount of light it still possesses shall disappear. Before you now burns a bright flame from a fish-tail burner. I may, as before, shout, clap my hands, sound a whistle or strike an anvil;

the flame remains steady and without response. I urge against the broad face of the flame a stream of air from the blow-pipe just employed. The flame is cut in two by the stream of air. It flutters slightly, and now, when the whistle is sounded, the flame instantly starts. A knock on the table causes the two half-flames to unite and form for an instant a flame of the ordinary shape. By a slight variation of the experiment, the two side-flames disappear when the whistle is sounded, and a central tongue of flame is thrust forth in their stead.

Passing from a fish-tail to a bat's-wing burner, I obtain this broad steady flame. It is quite insensible to the loudest sound which would be tolerable here. The flame is fed from this gas-holder, which places a power of pressure at my disposal unattainable from the gas-pipes of the Institution. I turn on more gas: the flame enlarges, but it is still insensible to sound. I enlarge it still more, and now a slight flutter of its edge answers to the sound of the whistle. Turning on a little more gas, and sounding again, the jumping of the flame is still more distinct. Finally, I turn on gas until the flame is on the point of roaring, as flames do when the pressure is too great. I now sound my whistle; the flame roars and thrusts suddenly upwards eight long quivering tongues. I strike this distant anvil with a hammer, the flame instantly responds by thrusting forth its tongues.

(To be continued.)

From the London Engineering, No. 62.

THE MACHINERY OF IRON-WORKS.

THE machinery of iron-works, although it has received some improvement of late years, still stands greatly in need of emendation. The whole of the Bessemer apparatus, whether the blowing engines, the hydraulic cranes or in any other part, is extremely well contrived, and reveals the hand of a competent mechanic. So, also, the machine for rolling wheel tires is a very creditable instrument, and the Nasmyth hammer, or its imitations, is a great improvement upon the old tilt. But even the effect of the Nasmyth hammer is too topical in the case of large masses of iron, and just inasmuch, as we have pointed out in another article, that in pile driving the effect of a rapid blow is rather to shatter the head of the pile than to drive it; so in a large mass of iron, a similar blow will only act on the surface without penetrating to the heart. An hydraulic squeezer, or, if we like the term better, an hydraulic hammer, acting more by pressure than by impact, would probably be found better than any existing hammer, or the same end might be attained as in the riveting machine by employing a very short cylinder with a very large diameter, but in such case either the cylinder or the anvil would require to be adjustable to suit different

thicknesses of forgings. In the hydraulic arrangement the same end would be attainable by making the cylinder of the ordinary length, and by propelling the piston only through a small portion of the stroke, whether that portion was near the top or the bottom. But in a steam hammer it would not be possible to do this without a waste of steam.

There is another ground of preference for an hydraulic squeezer over a common steam hammer, in the fact that it would not consume power by shaking the earth and houses in the neighborhood, which may, in some cases, be a serious annoyance, and which cannot be done without an expenditure of coal. Nor is it in the hammers alone that the hydraulic principle might be beneficially introduced, as it could also be employed to propel and reverse the rolls of the rolling mill. Even in the best works there is no visible improvement in the rolling mill during the present century, and it is still a very rude and imperfect instrument, and involves the use of too much manual labor. It would be quite practicable to introduce arrangements whereby rolled objects of whatever weight, would be received and delivered complete, without the interposition of manual labor at all, and this, especially in the case of heavy articles, would bring a considerable saving in the manufacture.

From the London Engineering, No. 62.

HUGON'S GAS ENGINE.

Messrs. Thomas Robinson & Sons, of Rochdale, have taken up the manufacture of Hugon's patent gas engines, and have just set the first engine to work on their premises. This engine has been imported from France; it works by explosions of gas mixed with air in a cylinder. The principal difference between it and the Lenoir engine consists in the mode of igniting the mixture. The Hugon engine effects this by carrying a flame of gas into the cylinder by means of a kind of slide-valve which has a gas-jet in each of its ports. The flame in the ports is extinguished by each explosion, and requires to be re-ignited for each stroke of the piston. This end is attained by bringing the slide-valve with its port in contact with a fixed gas-burner from which the jet in the port is ignited. There are two ports, one for each end of the cylinder, and accordingly there are two fixed gas flames placed opposite to the two openings in the slide-valve containing the traveling jet. The machine in its present state is encumbered with a considerable amount of complication, and in many respects requires the finishing touch of a practical engineer before it may be considered an accomplished fact. With regard to this there can be no doubt, that it is now in as good hands as need be wished for, and it will undergo a thorough reconstruction before it will be introduced into the general market.

(Continued from page 193.)

LECTURES ON VENTILATION.

Delivered before the Franklin Institute, by L. W. Leeds, Esq.

Let us illustrate this by a simple experiment. Here we have a very small tube, in which we place a lighted candle, occupying nearly the entire space—this burns brightly, you see.

Fig. 1.

Here we have another glass chamber, much handsomer and twenty times as large; we also place a similar candle in it, that burns with equal brightness, but watch them both for a few moments—see how rapidly this light in the large chamber diminishes in size.

Fig. 2.

That represents, in a beautiful manner, the diminished force of your life in an air-tight room. There it goes—entirely extinguished by foul air in so short a time, but the other continues to burn just as brightly as when first lighted. The smaller one had the window open, so to speak; we will imagine the candle in the large chamber to be a consumptive patient who thought the room so large he did not need the windows open. Remember, therefore, that no matter how small your room is, if there is a constant circulation of fresh air through it, the lamp of your life will burn brightly; but if ever so large and air-tight, your life will soon be extinguished.

Instead of avoiding the cholera by avoiding fresh air at night, the experience of the last summer seems to have taught us just the contrary; for whilst most physicians admit that they are still unable to explain satisfactorily, the cause or remedy for this most mysterious disease, that has within a lifetime carried its fifty millions of victims from time to eternity, they almost universally believe it is a foul air poison, and they have as yet found no surer prevention than pure air.

One of the most striking illustrations of this, and perhaps one of the most wonderful cures of cholera on record, was that of the New York Workhouse on Blackwell's Island. It lasted only nine days, but in that brief period one hundred and twenty-three out of eight

hundred inmates died. I visited the building with Dr. Hamilton, on the third day after its appearance, but the hospital then contained sixty or seventy patients, and some twenty-five or thirty had died within twenty-four hours.

Dr. Hamilton attributed the rapid propagation and fatality of the disease, after it once had gained admission, mainly to confinement and crowding. It was observed that the cholera was confined, for several days, among the women; the women had the smallest apartments, were most crowded in their cells, and with few exceptions, were employed within the building, in close contact with each other during the day. The men were employed mostly in the quarries and out of doors.

The doctor's prescription on that occasion is worth studying. It is very short and simple, however.

A slight change was made in the diet; disinfectants were used; fifteen drops of the tincture of capsicum with an ounce of whisky, as a stimulant at night, was all the medicine given to each individual. But the great means the doctor relied upon for success, was pure air all the time. They were kept out of doors from morning until night, and all the windows were kept open night and day; and although in the hot weather of summer, fire was made in the wards, to insure more perfect ventilation. In six days after the initiation of these simple hygienic measures, the epidemic entirely disappeared.

The disorders and sickness caused by the too rapid chilling of the unprotected body after sundown, have given rise, I have no doubt, to that erroneous popular prejudice so common among all classes, even those of education and ordinarily good common sense, who imagine there is some peculiar poison or source of unhealthiness in the air at night, that is not contained in the air in the day-time. It will no doubt greatly relieve the minds of these from such "vain terrors," and prove most conclusively the entire fallacy of such reasoning, to examine these tables again. In the copies I have made, I have not classified the results given by day and by night, but a careful examination in detail, fails to show any appreciable difference in the aggregate, by day or by night.

Méné's numerous experiments on the air in Paris, gave less carbonic acid at night than in the day-time.

Lewey's analysis on the Atlantic ocean, one thousand miles from the coast, gave a decided excess in the day over that of the night.

He attributes this to the action of the sunlight upon the ocean liberating the gases which it holds in solution.

In cities there is a much larger quantity given off from burning coals of factories in the day-time than at night.

It is not improbable, however, that the more rapid evaporation of moisture towards evening may carry with it the volatile particles of corrupted animal and vegetable matter to an extent slightly in excess of that which occurs in the morning, but it is believed these would not equal the greater contamination from burning coals, and the usually greater stillness of the air, producing partial stagnation, so that the air would be a little nearer pure at night than in the day-time. And how unmistakably do all these investigations prove what we ought to have known and accepted without a moment's hesitation, that the Creator that has made such vast and such minute provisions for supplying every living creature with a constant and copious supply of fresh air, has made it so important for their existence that they cannot live a moment without it, has made the air at night just as pure and wholesome as in the day-time.

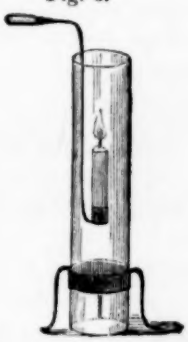
We have thus traced the scourge of foul air to our houses, and much of it to our bed-rooms. The next question is, how to get clear of it.

We want to know, however, what poisons the air, so as to know in what part of the room it is to be found.

We will try a very simple experiment, to show you what a deadly poison the breath is,—to the flame of a candle, at any rate.

Here is a simple glass tube, open at both ends—an ordinary lamp chimney—a candle burns freely as you see, and would burn so all night, if it did not burn out. I will now remove the candle, and breathe into the tube through this pipe, and now you see how suddenly the candle is extinguished as I drop it in again.

Fig. 3.



Animals are killed suddenly or after a more prolonged struggle, by the exhaled breath, according to the activity or sluggishness with which the blood circulates—a bird would be killed very soon—some partially torpid animals would live a long time. Man has great endurance—struggles long and hard; but if closely confined, will be poisoned to death in one night, as in the case of those confined in the celebrated Black Hole of Calcutta, and on board of

vessels where they have been confined below decks in time of a storm. Others will struggle on longer, as in the case of the two thousand and twenty-six who died of consumption last year, in Philadelphia.

And now let us see in which part of the room this deadly poison of our breath is mostly found.

It is the popular idea, that because the body, and consequently the breath, is warmer than the ordinary temperature of a room, that it rises and accumulates at the ceiling.

Upon this theory most of our buildings have been ventilated whenever any attention whatever has been given to that subject, but that theory is incorrect; consequently, all practice based thereon is also wrong.

This subject of the direction taken by the breath upon leaving the body, has been warmly discussed within a few years. It has been a very difficult matter to prove conclusively and satisfactorily, but I think we have devised some very simple experiments that will prove to you very clearly what we have stated.

I have here a simple glass tube two feet long and one and a half inches interior diameter; one end is closed with a rubber diaphragm, through which is passed a small rubber tube—the other end is all open. We will rest this about horizontal, and taking a little smoke in the mouth, it will be discharged with the breath into the glass tube; it is first thrown towards the top, but it soon falls, and now see it flowing along the bottom of the tube like water—watch it as it reaches the far end—there, see it fall almost like water.

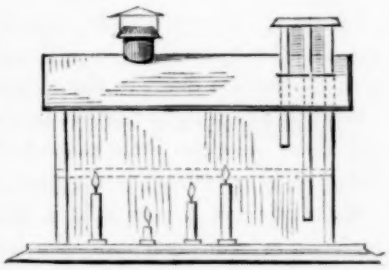
Now, by raising the closed end of the pipe, you see we can pour it all out, and by filling it again and raising the other end, it falls back.

Thus you see that, notwithstanding the extra warmth in the breath, it is heavier than the atmosphere, and falls to the floor of an ordinary room like this, say when the temperature is from 60° to 70°. This is owing to the carbonic acid and moisture contained in it.

I have varied this experiment in a number of ways, by passing it through smaller tubes and discharging it into the air in one or two seconds after leaving the lungs, and by passing it through water of various temperatures, and discharging it into rooms of different temperatures, with the same general results. As the temperature of the air diminishes, the tendency of the discharged breath to rise increases. Much care is required in conducting these experiments,

to avoid as much as possible, the local currents which are always present in a room.

This is a very important fact to be borne in mind; yet notwithstanding this, there are times, under certain circumstances, in which the foul air will be found in excess at the top of the room.



For the further examination of this subject, we have here a little glass-house with glass chimneys and fire-place in the first and second stories.

As the flame of a candle is such a beautiful emblem of human life, we will remove the roof and part of the floor of the second story, and place four candles in our house. They are all of different heights, you see. We will call them a father, mother and two children.

As carbonic acid is that much dreaded poison in our breath, and the heavy portion of it which causes it to fall to the floor, we will make a little by placing a few scraps of common marble in this glass vessel, and pouring over it some sulphuric acid.

It is now forming, and will fall and flow across the floor the same as carbonic acid does when it pours into a basement from the gutters on the street or filthy yards where it is formed, and before it is absorbed or diluted by the current of pure air sweeping over them. It first kills the smallest child, because it is nearest the floor. You remember the excessive infantile mortality in this city in 1865. This is partially owing to their breathing more of this foul air near the floor, and partially owing to the great fear of their mothers and nurses, of letting the little innocents get a breath of fresh air for fear it would give them colic, and consequently they smother them to death.

The other child dies next, and then the mother, and lastly the father.

Thousands are thus poisoned to death by their own breath every year. But did you ever see a physician's certificate that ever gave you any such idea? Why do not the doctors tell the living, in such language as they can understand, what killed their friends, so they may avoid it in their own case, instead of giving it in some Latin terms which I fear many interpret to mean some special dispensation of Divine

Providence instead of the true cause—their utter disregard of the laws their Creator made for the preservation of their health?

Had this family known enough about ventilation to have kept the fire-place open, with a little fire in it now and then, they would not have been thus killed.

Let us see—we will take out the fire-board which has been put in to make the room look a little neater, and with a very small light there to create a draft in the chimney.

We will again light the candles, and pour in the poisonous breath. Ah! there goes the little one—he is hardly high enough to keep out of that deadly current flowing across the floor.

We shall have to let it in a little slower, or we will set him on a platform, as many persons who have carefully studied this subject, consider it judicious to do. Now, by the smoke from this taper, you can see the air is flowing across the floor and up the chimney.

There has been a steady current flowing in long enough to have filled the house, but the lights are all burning brightly, and you thus see the value of an open fire-place for ventilation. Thousands of lives are thus saved, and many more would be if all fire-places were kept open. I have recommended hundreds of fire-boards to be cut up for kindling-wood, as I consider this is the best use that can be made of all fire-boards.

Never stop up a fire-place in winter or summer, where any living being stays night or day. It would be about as absurd to take a piece of elegantly tinted court-plaster and stop up the nose, trusting to the accidental opening and shutting of the mouth for fresh air, because you thought it spoiled the looks of your face so to have two such great ugly-looking holes in it, as it is to stop your fire-place with elegantly tinted paper because you think it looks better.

If you are so fortunate as to have a fire-place in your room, paint it when not in use; put a boquet of fresh flowers in every morning, if you please, or do anything to make it attractive, but never close it.

Now, there are other conditions in which a fire-place or an opening near the floor, will not answer for ventilation. This occurs in rooms where the air is made impure by burning lamps or gas, and where the fresh air entering the room is cooler than the temperature of the room itself.

To illustrate this, we will put the roof on and take the entire floor away, or as it will be a little more convenient, we will represent it by this glass-house, using this shade for that purpose.

This is supported some six inches from the floor, and has no bottom. By lighting another candle and standing it outside, you can judge by comparison, of the foulness of the air inside.

The tallest one is effected first, this time. You see that is a perfectly formed light, but it gives but about half the light the one does on the outside; this is the way with many of us who are obliged to, or rather do, breathe foul air half the time.

We often think, by comparing ourselves with others around us, that we are pretty fair specimens of humanity, while really we do not give more than half the light in the world that we ought to do, and kill ourselves before our work is half done.

You see the two tallest are dead already, and the others will soon follow—there they go. Here is the bottom of the house removed, and yet these candles all went out for want of fresh air.

Therefore, when we see the air is made impure by burning candles or gas lights, owing to its exceeding heat, the foul air is mostly at the top of the room, and especially when the fresh air enters cooler than the air in the room. We will find, however, that in a very few minutes the candles will relight long before the contained air or the glass shade cools down to the temperature of the room.

The products of combustion, like those of respiration, are heavier than the ordinary atmosphere, and consequently fall to the floor very soon if not removed while very hot, by special openings immediately over them in the ceiling; after it has thus fallen, provision must be made for its removal from the level of the floor, in connection with the foul air from the breath.

I hope by these few simple experiments, and the statistics presented here this evening, we have strengthened your previous convictions of the importance of fresh air, because we are well aware that you will find, as you proceed in your investigations of this subject, that it is frequently surrounded with complications, yet the laws governing the circulation of air of different temperatures, are as fixed and immovable as the laws governing the rising and setting of the sun, and with a very little careful investigation, can be easily understood.

And we believe no similar amount of money or thought, will produce a greater amount of satisfaction than the increased health, strength and happiness thus secured.

(To be continued.)

EXPERIMENTS ON THE EVAPORATION OF STEAM-BOILERS USED FOR HEATING PURPOSES.

By JAMES B. FRANCIS, Civil Engineer.

BOILERS IN THE MILLS OF THE NASHUA MANUFACTURING COMPANY, AT NASHUA, N. H.

THIS experiment was made at the request of Gen. J. C. Palfrey, agent of the Merrimack Manufacturing Company, at Lowell, Mr. Daniel Hussey, the agent of the Nashua Manufacturing Company, furnishing all the facilities required for the purpose.

The boilers were built by the Lowell Machine Shop, and have been in operation since September last. They are plain tubular boilers. Each boiler is twenty feet long and five feet in diameter, with fifty-five wrought iron tubes, 3·25 inches in diameter inside, and about one-eighth of an inch thick. The usual level of the water is about twenty-two inches below the top of the boiler. The grates are placed under the boilers, and are each 4·86 feet long and 5·545 feet wide, having a total area, under both boilers, of 53·9 square feet. The grate-bars are in three lengths, and the spaces between them are about a quarter of an inch in width, and have a total area under both boilers of about 15·19 square feet.

The products of combustion pass, first, under the whole length of the boilers, about one-half of the area of the shells being heating surface; thence returning through the tubes; thence back again through the flues of a heater, placed above and between the two boilers. The heater is about eighteen feet long and forty-three inches in diameter, and has two flues 1·19 feet in diameter.

Fire surface in the shells of the boilers, including that portion of the ends below the water-line	369	square feet.
Fire surface in the tubes	1873	" "
Fire surface in the heater	160	" "
Total area of fire surface	2402	square feet.

The boilers and heater having 44·56 square feet of fire surface to each square foot of grate surface. The boilers and heater are protected from radiation by brick-work and ashes.

The products of combustion from three pairs of boilers pass into a

chimney, about one hundred and ten feet high, having a flue of a uniform section of about nine square feet. In the lower part of this chimney there is a damper, regulated by the pressure of the steam. Each set of boilers has also a separate damper, regulated by hand. During this experiment all the boilers were in operation in the daytime, while the mills were running, and the draught was regulated by the self-acting damper, the hand-damper being generally wide open. In the night, when the boilers being experimented on were alone in operation, the draught was regulated by the hand-damper, the self-acting damper being generally wide open. The dampers all turn on axes, on the principle of the throttle-valve; their positions were noted by means of arcs, graduated in degrees, the indices of both reading 0 when shut, and that in the main chimney reading 65° when wide open, and that in the flue reading 90° when wide open.

The fire surfaces of the boilers and heater were cleaned, and the boilers blown off, within the two days next preceding the commencement of the experiment. This is usually done once a week.

The boilers were supplied with water from a cast iron tank, 4·83 feet in diameter and 5·91 feet high, which was partially filled with water, at intervals, from the town water-pipes, and the water pumped from the tank into the heater, which is kept constantly full and under the same pressure as the steam in the boilers, the water flowing from the heater into the boilers as fast as it is pumped into the former.

The experiment consisted, mainly, in noting the quantity of water pumped from the tank into the heater, during a certain interval of time, and the quantity of coal consumed under the boilers during the same time. In order to ascertain the quantity of water, a glass tube, about six feet long, was attached to a wall near the tank, which was connected at its lower end with the tank by a pipe, so that the water stood at the same level in the tank and pipe; a graduated scale was attached to the glass tube.

In order to gauge the tank, a cask was filled with water to a certain height, and the weight of the water ascertained by platform scales. The tank was then filled by means of this cask, the height of the water in the glass tube being noted after each cask of water was put in, which gave the means of determining, at any time, the weight of water in the tank by an inspection of the height of water in the glass tube.

The pumps being stopped, the tank was filled to a convenient height, which was noted. The pumps were then put in operation, and

the boilers supplied in the usual manner. When the water in the tank was nearly exhausted, the pumps were stopped and the height of the water in the glass tube again noted, which gave the means of ascertaining the quantity of water remaining in the tank, which being deducted from the original contents of the tank, gave the quantity supplied to the boilers for that filling of the tank. This operation was repeated as often as necessary, to keep the boilers supplied with water.

The coal was weighed out at intervals, on the same scales as were used to determine the weight of water in the tank.

The experiment commenced at 3h. 30m. P. M. on Monday, February 11th, 1867, and terminated on the following Saturday, at 3h. 0m. P. M., an interval of 119·5 hours, during which time the fires were maintained with as much uniformity as practicable, two sets of firemen and observers being employed. The temperatures of the air and water were noted; also of the smoke in the flue between the boilers and heater, and in the flue just beyond the heater. Also, the pressure of steam in the boilers, the position of the dampers and the amount of ashes and clinkers.

Care was taken to terminate the experiment when the fire was in the same state as when it commenced—at least, as nearly so as could be ascertained by inspection. The height of the water in each boiler was also noted at the commencement and termination of the experiment, and a correction made for the difference.

Steam-boilers frequently carry over water with the steam, and it is often quite difficult to ascertain how this is, particularly when the quantity carried over is not large. In this case, there was little probability of it, the steam space being larger than usual in boilers used for heating purposes, and the boilers of simple form, very clean and moderately fired. But to get some positive information on this point, I put in a diaphragm at a joint in the horizontal pipe, four inches in diameter, conducting the steam from one of the boilers; the upper part of this diaphragm was cut away, so as to leave an aperture, for the passage of steam, of an area equal to about three-fourths of the area of the pipe, the part not cut away operating as a dam to prevent the free flow of water along the bottom of the pipe. A small cock was put in the bottom of the pipe, on the side of the diaphragm farthest from the boiler, where, from the position of the pipes, water would be likely to lay, if any was carried over from the boilers. This cock was frequently opened during the experiment, but on no occasion was any water found, except the small quantity condensed in the cock.

From all the circumstances, I infer that very little, if any, water passed over except in the form of steam.

The coal used was anthracite, but I was not able to learn, definitely, the kind. It was taken from a shed in which five cargoes, amounting to 1718 tons, were promiscuously deposited last spring. Two of the cargoes were "Locust Mountain" and another "Broad Mountain;" another was called, in the invoice, "White Ash," and another "Bear Valley." From the manner in which the coal was originally deposited in the shed, I infer that the coal used in this experiment was a mixture of these several kinds. The coal was of the size called "broken," containing the usual amount of dust and dirt, which was weighed in and used, and may account, in part at least, for the large proportion of clinkers.

The following are the results of this experiment:

Water evaporated	296,620 pounds.
Mean initial temperature of water in tank	36° Fahr.
Coal consumed under boilers, including ashes and clinkers	34,197 pounds.
Ashes, being everything that fell through the grates	1,963 "
Clinkers	2,138 "
Mean pressure of steam in boilers, above atmosphere	31·4 lbs. pr sq. in.
Mean thickness of the fires	7·2 inches.
Mean opening of hand-damper during the night	54°
Mean opening of the self-acting damper during the day	35°
Mean temperature in flue between the westerly boiler and the heater	296° Fahr.
Mean temperature in the flue just after leaving the heater	237° "
Mean temperature by thermometer in boiler room	67° "
Mean temperature out-doors, in shade	35·9° "
Water evaporated from the initial temperature in the tank, by one pound of coal	8·674 pounds.
Equivalent amount of water evaporated from 212° by one pound of coal	10 201 "
Coal burned per square foot of grate per hour	5 309 "
Proportion of ashes and clinkers to the coal	12 per cent.

The ashes contained a considerable proportion of fine coal, partially burned, which was not returned to the fire. The clinkers were not picked over with much care, and a greater quantity of partially burned coal might have been separated and returned to the grate, which would probably have increased the evaporation slightly.

SYNOPSIS OF EXPERIMENTS ON THE EVAPORATION OF SEVERAL BOILERS USED FOR HEATING PURPOSES, MADE UNDER THE SAME DIRECTION AS THE PRECEDING.

February, 1840.—Upright cylindrical boiler in Massachusetts Cotton Mill, No. 1, 31¼ inches diameter, 11 feet high. Fire inside, surrounded by a 3-inch water space, which extended nearly to the level of the surface of the water. Over the fire there was a pot, leaving an annular space about three inches wide, for the passage of the products of combustion, which left the boiler by an opening through the water space.

Area of grate surface	3·21 sq. feet.
Area of fire surface	114·25 " "
Fire surface to one square foot of grate surface	35·59 " "
Anthracite coal burned per square foot of grate per hour	12·75 pounds.
Water evaporated from 212° by one pound of coal	7·87 "

February, 1841.—Two upright cylindrical boilers in Massachusetts Cotton Mill, No. 2, similar to the preceding, except that they are one foot higher, and the annular flue extended through the steam space to the top of the boiler.

Area of grate surface in each boiler	3·20 sq. feet.
Area of fire surface in each boiler	126·50 " "
Fire surface to one square foot of grate surface	39·53 " "
Anthracite coal burned per square foot of grate per hour	7·15 pounds.
Water evaporated from 212° by one pound of coal	12·06 "

April, 1851.—Upright cylindrical boiler in Massachusetts Cotton Mill, No. 1, similar to the next preceding, except that the pot contained a flue $9\frac{3}{12}$ feet in height, and 11½ inches in diameter.

Area of grate surface	3·14 sq. feet.
Area of fire surface	154·34 " "
Fire surface to one square foot of grate surface	49·15 " "
Anthracite coal burned per square foot of grate per hour	13·42 pounds.
Water evaporated from 212° by one pound of coal	9·62 "

January, 1851.—Locomotive boiler at the Boott Cotton Mills. The products of combustion passed from the fire-box, which was surrounded by water, through 64 tubes 2⅜ inches diameter, 13¾ feet long, to a smoke-box, also surrounded by water; thence back under the boiler through a heater.

Area of grate surface	16·66 sq. feet.
Area of fire surface, including heater	748·00 " "
Fire surface to one square foot of grate surface	44·90 " "

1st Trial. The surface of the boiler not being protected from radiation.

Anthracite coal burned per square foot of grate per hour....	5·84 pounds.
Water evaporated from 212° by one pound of coal.....	8·88 "

2d Trial. The surface of the boiler being protected from radiation, by felting and brick-work.

Anthracite coal burned per square foot of grate per hour...	7·52 pounds.
Water evaporated from 212° by one pound of coal.....	9·43 "

3d Trial. Same circumstances as the preceding, except that bituminous coal, from the Vossburgh mines, in Maryland, was used.

Bituminous coal burned per square foot of grate per hour,	7·61 pounds.
Water evaporated from 212° by one pound of coal.....	10·57 "

February, 1851.—Three horizontal cylindrical boilers at the Boott Cotton Mills, each boiler 20 feet long and 30 inches in diameter, with the two flues 11 inches in diameter.

Area of grate surface.....	38·70 sq. feet.
Area of fire surface.....	590·00 " "
Fire surface to one foot of grate surface.....	15·25 " "
Anthracite coal burned per square foot of grate per hour..	4·44 pounds.
Water evaporated from 212° by one pound of coal.....	7·53 "

Lowell, Mass., Feb. 22, 1867.

DESCRIPTION OF PARHELIUM OBSERVED AT GERMANTOWN.

By C. J. W., Jr., February, 1865.

MR. EDITOR: The exhibition of the phenomenon of parhelium, which occurred on Monday, the 4th inst., was of so remarkable a character that the writer has thought it deserving of more than a passing notice, and has therefore prepared the following sketch of its principal features for insertion in your *Journal*.

In the early part of the day mentioned, the sky was unusually clear, the sun brilliant, and the atmosphere, for the season, mild and calm. At 7 o'clock A. M., the thermometer was 30°, with a light southwest breeze. Towards noon, however, the sky became overcast with

a thin haze, and about 1 P. M. the writer's attention was attracted to a point in the heavens, a little to the south of west, by a luminous arc, exhibiting the prismatic colors, which, superficially observed, might have been mistaken for a rainbow. As there was no rain, or even mist sufficient for the formation of a rainbow, the writer was led to suspect the cause of the phenomenon, and upon casting his eyes to the south-eastern heavens, perceived a corresponding arc, which at once convinced him of its true character. Upon further observation, the following particulars were observed: 1 o'clock P. M., thermometer, 46°; barometer, 29·55 ins.; wind, south-west, light; sun's altitude, 33°. Owing to the hour of the day, it is evident that the sun occupied a position in the heavens but little to the west of south, and that he had but just passed his meridian height. At a distance of 40° on either side, with the sun as a centre, and about 15° from the horizon, were the prismatic arcs first observed, having a nucleus in the centre, and gradually diminishing in brightness towards the extremities. The peculiar feature of these arcs was, that they were not concentric with the sun, but, on the contrary, that their convexity was towards him. This peculiarity was observed in a parhelium seen by Hevelius, at Dantzic, in 1661, and is the only instance that the writer is able to find on record.

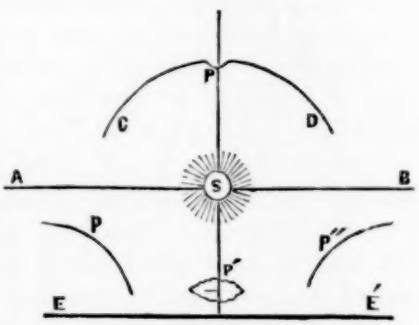
In a perpendicular line, passing through the sun, were to be found two of the most interesting features of the phenomenon witnessed; that between the sun and the zenith, and about 25° from the former, consisted of a concentric, prismatic arc, similar to those already described, except that it was larger and far more brilliant, and that directly in the intersection of the line connecting the sun with the zenith a distinct depression existed, causing the arc to deviate very materially from the line of a circle. The corresponding point below the sun, also at a distance of 25°, was brilliantly illuminated, and by far the most distinctly marked of the parhelia visible, having the appearance of the sun about to burst from behind a cloud. This also faintly exhibited the prismatic colors. The last, and perhaps the most interesting feature observed, was a great circle of white light, horizontally placed, passing directly through the sun's centre. This circle was almost complete, the writer having been able to trace its entire course, with the exception, perhaps, of 20° or 30°, in the eastern heavens. This unusual phenomenon was observed at Rome, by Schreiner, in 1629, connected with a parhelium of four suns, the same number as were observed on the present occasion.

The appearances above described continued with waining brilliancy for about half an hour, and had altogether disappeared in the course of an hour; they were far superior to any display accompanying parhelium ever observed by the writer, who has been so fortunate as to witness it three times, and similar phenomenon of the moon (parselene) once.

In confirmation of the impression that the state of the atmosphere necessary to the production of parhelium is indicative of a change of weather, the writer would merely observe, that by 2 o'clock P. M., on the day in question, the wind had veered to the east, and the sky had shortly afterwards become densely clouded; and that by 5 o'clock rain fell. In explanation of this, it is only necessary to say that the phenomenon of parhelium is ascribed to the existence in the atmosphere of a quantity of frozen spiculæ, floating in a thin fog, the coronæ being formed in the fog and the parhelia in the spiculæ, and that the spiculæ often subsequently fall in the form of cylindrical snow flakes, or melted in the form of rain.

In order that the above description may be more readily understood, I have prepared the annexed diagram, in which are embraced the principal features of the phenomenon.

The parhelia were observed at the four points marked P P P′ P″.



DESCRIPTION OF CUT.

C P D. Arc showing prismatic colors.
A B. Great circle of white light, horizontally placed, passing through the sun's centre.
P and P″. Prismatic arcs.
P and P′. Luminous spots.
E. E′. Horizon.

EDUCATIONAL

(Continued from page 203.)

LECTURES ON ELECTRICITY AND LIGHT.

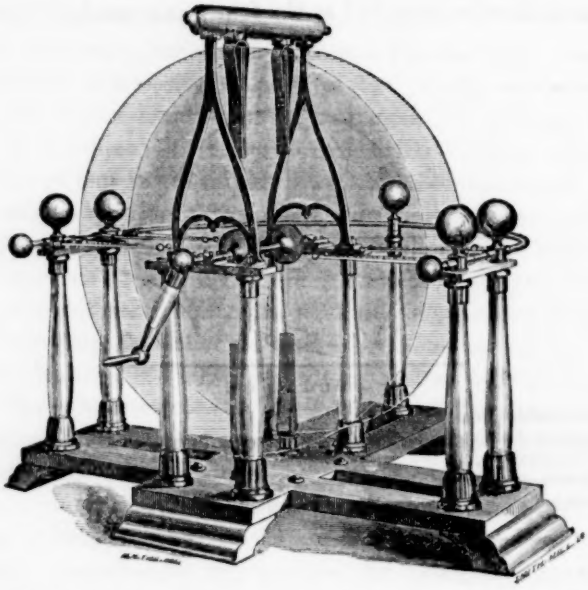
Delivered before the Franklin Institute, by PROF. HENRY MORTON, PH.D.

HAVING now described the general construction of the ordinary electrical machine, and the important points to be regarded in securing its best effect, it may be interesting to notice some remarkable machines which have been manufactured, of the above general type, but distinguished by special features, either of magnitude or constructive detail.

There was built, in 1856, by Mr. E. S. Ritchie, of Boston, for the University of Mississippi, a double plate machine of gigantic proportions and enormous power.

Fig. 7 represents the machine alone, without its prime conductor,

Fig. 7.



which consisted of three cylinders, about one foot in diameter and seven feet long, which were mounted on separate stands.

The plates of this machine are each six feet in diameter, and are excited by eight rubbers of brass, lined with fine wool felt $\frac{3}{8}$ of an inch thick, covered in turn with stout India silk, on which the amalgam is spread. Negative electricity can be obtained from the upper system of rubbers, which are connected with the small cylindrical conductor at the top.

This machine cost $3000 without any of its adjuncts, such as the Leyden battery of one hundred jars, having an aggregate surface of about ninety square feet. A single turn of this machine filled a room with an overpowering odor of ozone. No description has ever been published of the results obtained with this instrument, and even its constructor, Mr. Ritchie, (to whose kindness we are indebted for the use of the accompanying cut,) tells me that he cannot furnish information on this subject, as the instrument was sent to its destination immediately on being finished, and that no accounts have been received concerning its operation. This silence, for the last few years, is easily explained by the disturbed state of that section of country, but we may hope before long to have some record of experiments, which would be very interesting, as this is the largest machine of the sort ever constructed.

A few words may be here said as to the special properties of large machines. Increase in the size of the machine, secures an increase in the quantity of electricity developed, and as a secondary result of this, an increase in the spark length. Thus, the machine made by Cuthbertson, in 1755, for Von Marum, with double plates five feet five inches each in diameter, gave sparks of two feet in length.

An ordinary machine, with a plate of thirty inches, on the other hand, is doing very well if it gives sparks of five inches. The reason of this is easy to understand. The large machine can readily supply a large prime conductor, and notwithstanding the increased leakage of this, can accumulate in it a proportionally large amount of electricity. On such a large conductor, the tension may rise higher, before dispersion takes place, into the air, for the reasons already mentioned (page 202), as well as for other causes which will be better understood in connection with the distribution of electricity in conductors, which we shall discuss further on.

In addition to this, all the oppositely excited parts are further apart in the larger machine, and all the terminations are in longer curves, for which case there is, *in proportion*, less loss from leakage. So regular in fact is this increase in spark length in following the

enlargement of the machine, that it was at one time assumed as a fair index in general, of the magnitude and value of the apparatus.

(To be continued.)

(Continued from page 206.)

MAGIC LANTERN AS A MEANS OF DEMONSTRATION.

In place of hydrogen, obtained by any of the means before described, the ordinary illuminating gas may be employed with an equally good effect in all but a few spectrum experiments, to be described in future. To obtain an equal light, however, it is necessary to employ a heavier pressure than is required with hydrogen.

As a practical question, the choice of one or the other material will be determined by local conditions, and especially by the character of the reservoirs used for storing the gases, and after these have been discussed, we will again briefly allude to this matter.

Methods of Storing Gas.

Gas bags of rubber cloth are perhaps most largely employed for the above purpose, and, with certain drawbacks, are of great service. To keep them in good condition, they must be treated with great care, especially after they have once been in use. They should not be rolled or folded, but put away when not in use, on a large shelf where they may lie out flat. They should not be inflated or compressed when rigid from cold, and after use with burning-gas, should be entirely emptied and rinsed with air by means of a bellows, with which they may be partly inflated, and then emptied two or three times in succession. If these precautions are neglected, the life of a gas bag is but short, as is the case with those traveling from place to place, where a few months limit their useful existence. But with care and under favorable conditions, I have had them last for two years, with pretty constant use. Their cost is small—a 30 by 40-inch bag of wedge-shape, and having a capacity of forty to fifty gallons, according to its distension, is sold by R. Levick, 708 Chestnut Street, for $12. This does not include brass connector and stop-cock, which, however, once procured, will last indefinitely. Stop-cocks of hard rubber cost $2 each. To force out the gas from these bags, press-boards and

weights of some sort must be employed. For press-boards, mere strong drawing-boards or pie-boards may be employed, the bags being spread upon the floor, the boards upon them, and the weights so adjusted as to preserve an equilibrium. If two bags are used, this, however, requires a double set of weights, and each large bag demanding two hundred and fifty pounds (when nearly empty), this is an important point. Also with bellows-shaped bags, some means must be employed to prevent sliding. For two bags, it is therefore better to have press-boards made of three pieces, hinged together like the letter N, turned on its side, thus Z; a bag being placed in each angle, the stop-cocks passing through holes cut in the wood at these points. One set of weights then compresses both bags, and the whole being connected and steady, equality of pressure is readily obtained by adjustment in the position of the weights; moving them

Fig. 5.

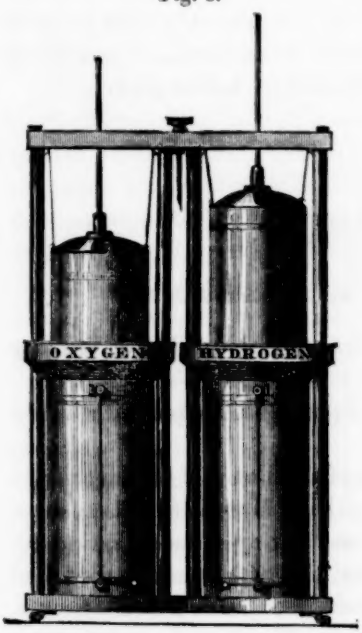
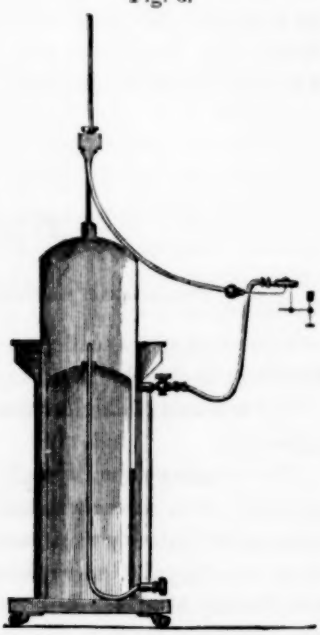


Fig. 6.



to the right (see the overturned letter above) increases the pressure on the lower bag and diminishes it upon the upper, moving to the left, the reverse.

The hinges used should be very strong, like gate hinges, and *riveted* to the wood, then covered by a strip of canvas or oil-cloth, to protect the bags. For weights, twenty-eight pound blocks are the easiest to

handle, but fifty-sixes, buckets of water, coal scuttles, sand-bags and small boys, may all come in play on occasion.

Gas holders, such as are represented in Figs. 5 and 6, may be next mentioned. As fixtures in a laboratory (*i. e.*, only to be moved about the room in which they are used) these are very convenient. They are absolutely tight, so that a supply may be kept on hand for any time, without loss or deterioration, while in the best gas bags a month's storage seriously impairs even oxygen.

No handling of heavy weights is required, as that producing pressure may be left on permanently, and if removed, is relatively small. The pressure during use is absolutely constant, and the whole apparatus practically indestructible. The pattern here shown, is that furnished by Mr. Ritchie, of Boston, who is so widely known by reason of his great improvements in the Induction Coil.

Fig. 5 shows an elevation of a pair of these gas holders mounted on a movable platform which runs on castors, and may thus be easily transferred from one part of a room to another. Fig. 6 shows a section of one holder with the attachment of a blow-pipe.

(To be continued.)

Franklin Institute.

Proceedings of the Stated Monthly Meeting, March 20th, 1867.

THE meeting was called to order with the President, Mr. J. Vaughan Merrick, in the chair.

The minutes of the last Stated and Special Meetings were read and approved.

The Actuary submitted the minutes of the Board of Managers, and reported that, at their stated meeting, held March 13th inst., donations to the Library were received from the Royal Astronomical Society, the Royal Geographical Society, the Statistical Society, and the Society of Arts, London, England; L'Academie des Sciences, Paris, and la Société Industrielle, Mulhouse, France; the Smithsonian Institution and Chas. Colné, Esq., Washington, D. C.; S. S. Garrigues, Esq., Lansing, and the Board of Water Commissioners, Detroit, Michigan; Managers of the State Lunatic Asylum, Utica, New York; Trustees of the Gas Works and Messrs. Wm. I. Mullen, Frederick Fraley, George Erety and Samuel V. Merrick, Philadelphia.

The various Standing Committees reported their minutes.

The Special Committee on Experiments in Steam Expansion reported progress.

The Special Committee on General Totten's letter, relating to the appointment of a Government Bureau of Mechanical Examination and Experiment, reported as follows:

The Committee appointed to consider the scheme for the establishment of a "Permanent Examining Board for the Army," as proposed in a letter from General Totten, respectfully

REPORT

That they consider that the establishment of such a Board would be beneficial to the interests of the government and the public, but that in the proposed form it would be too expensive, as it involves the time and services of the most useful and accomplished officers, and of a large number of assistants, while there might frequently be times at which there would be no business for the Board to do.

It is also suggested that the National Academy of Sciences, which numbers among its members several officers of the army and navy eminent for their scientific attainments, was established for the expressed purpose, among others, of examining into matters referred to it by any department of the government, and this it is constantly doing by its Committees. Provision is made for the addition of persons not members of the Academy to these Committees, and in this way the services of any officer may be secured. By the law, no compensation can be paid to the members of the Academy; but this does not extend to the added members of the Committees, and any amount of money may be furnished by the government for the expenses of experiment.

For the more elaborate investigation of any invention that has been favorably reported on, a special Board of officers may be convened at any of the arsenals or navy yards, at most of which great facilities exist for experimenting on a large scale.

There has been for some time in existence in the navy department a "Permanent Board or Commission," composed of not more than five members, scientific officers or civilians who happen to be residing in Washington, to whom inventions are referred, and through whose hands an immense number have passed.

A Board of the same kind, composed of officers of *both* services, together with civilians, might be readily established at a mere nominal

cost. It must be borne in mind, that the large proportion of inventions brought forward are entirely worthless, and can be disposed of very quickly, while important ones can be referred to special Boards or Committees.

The Committee, therefore, offer the following resolution:

Resolved, That while in the opinion of the Institute, it is desirable that there should be some way by which inventions, touching either the military or naval services, could be promptly examined and disposed of, the plan proposed by General Totten, of establishing a permanent Board, is too elaborate and expensive, and that it would be better to refer such inventions, first, to the National Academy of Sciences, or to a small permanent Board such as described in the latter part of the report, and then, if necessary, to a special commission of officers and others, ordered for the purpose of more thorough investigation.

Respectfully submitted,

FAIRMAN ROGERS,
WM. J. HORSTMANN,
HENRY G. MORRIS,
J. S. WHITNEY,
J. VAUGHAN MERRICK,
} Committee.

The Special Committee to prepare a memorial to Congress with reference to the establishment of a Uniform Code of Danger Signals reported progress.

The Special Committee appointed to attend the obsequies of Prof. Bache reported that they had fulfilled the duties required of them, and were discharged.

The Committee on an ordinance to provide for the inspection of steam-engines and boilers reported their minutes.

The paper announced for the evening on Ground Batteries, by Mr. A. G. Ballantyne, was then read, and various remarks were made upon the same by Professor Robert E. Rogers, Mr. Coleman Sellers and others.

(The abstract of this paper, and of the accompanying remarks, will be published in the next number of this *Journal*.)

Various communications were then made by different members on various subjects, an abstract of which will be found under the appropriate heads in the editorial department.

The meeting was then, on motion, adjourned.

HENRY MORTON, *Secretary*.

A COMPARISON *of some of the Meteorological Phenomena of* FEBRUARY, 1867, *with those of* FEBRUARY, 1866, *and of the same month for* SIXTEEN *years, at Philadelphia, Pa.* Barometer 60 feet above mean tide in the Delaware River. Latitude 39° 57½′ N.; Longitude 75° 11½′ W. from Greenwich. By PROF. J. A. KIRKPATRICK, of the Central High School.

	February, 1867.	February, 1866.	February, for 16 years.
Thermometer—Highest—degree	55·00	60·00	70·00°
" date	14th.	11, 23 & 24th.	23d, '60.
Warmest day—mean	51·83	55·00	59·30
" " date	14th.	24th.	25th, '57.
Lowest—degree	16·50	7·00	—1·00
" date	11th.	16th.	7th'55;8th'61
Coldest day—mean	24·33	15·00	4·50
" " date	10th.	16th.	6th, '55.
Mean daily oscillation	14·64	13·11	13·46
" " range	6·43	7·42	7·17
Means at 7 A. M.	35·84	30·87	29·79
" 2 P. M.	43·36	39·16	38·74
" 9 P. M.	40·66	35·68	34·04
" for the month	39 95	35·24	34·19
Barometer—Highest—inches	30·970	30·547	30·970
" date	11th.	17th.	11th, '67.
Greatest mean daily pressure	30·862	30·475	30·862
" " " date	11th.	26th.	11th, '67.
Lowest—inches	29·303	29·392	29·065
" date	3d.	14th.	23d, '53.
Least mean daily pressure	29·398	29·529	29·227
" " " date	3d.	1st.	16th, '56.
Mean daily range	0·279	0·245	0·225
Means at 7 A. M	30·087	30·032	29·934
" 2 P. M	30·053	29·964	29·887
" 9 P. M	30·065	29·999	29·918
" for the month	30·068	29·998	29·913
Force of Vapor—Greatest—inches	0·361	0·424	0·549
" date	14th.	24th.	16th, '57.
Least—inches	·049	·048	·013
" date	10th.	16th.	6th, '55.
Means at 7 A. M	·171	·151	·141
" 2 P. M	·174	·170	·159
" 9 P. M	·193	·175	·159
" for the month	·179	·165	·153
Relative Humidity—Greatest—per cent	95·0	95·0	100·0
" date	2d & 20th.	8th.	Often.
Least—per cent	27·0	30·0	20·0
" date	27th.	1st.	22d, '64.
Means at 7 A. M	76·8	79·9	78·4
" 2 P. M	60·2	65·2	63·0
" 9 P. M	72·7	76·1	75·0
" for the month	69·9	73·7	72·1
Clouds—Number of clear days*	6·	13·	8·3
" cloudy days	22·	15·	19·8
Means of sky covered at 7 A. M	65·3 per ct	45·7 per ct	60·6 per ct
" " " 2 P. M	68·2	58·9	61 2
" " " 9 P. M	61·4	41·1	48·7
" " for the month	64 9	48·6	56·8
Rain and melted snow—Amount—inches	4·820	6·637	3·277
No of days on which rain or snow fell	12·	8·	10·0
Prevailing Winds—Times in 1000	s 73°30′ w·181	s 70°38′ w·265	s 75°40′ w·274

* Sky one-third or less covered at the hours of observation.